ENGINEERING RECORD

A WEEKLY JOURNAL DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

PUBLISHED BY THE McGRAW PUBLISHING COMPANY, INC.

Volume 68 NEW YORK, SATURDAY, OCTOBER 11, 1913 Number 15

Dayton Flood Report Though only of a preliminary character, the report of the Morgan Engineering Company on flood prevention at Dayton, abstracted on another page of this issue, is of special interest because of the general similarity of its findings to those of Messrs. Alvord & Burdick at Columbus. Both firms conclude that adequate protective measures are feasible by merely local improvements, and that a system of reservoirs would not only be of material benefit to Columbus and Dayton but, also, to all the communities near them in the respective valleys. In both cases, too, the chief city can very considerably reduce its expenditure if the others will co-operate in the construction of a reservoir system. In one respect, however, the report goes contrary to general expectations. Since the March flood loss at Columbus was about $5,600,000 and the Dayton loss about $100,000,000, it was expected that the protective works for Dayton would cost much more than at Columbus. The two reports indicate, however, that the cost will be approximately the same. It would appear, therefore, that flood protection, from a purely financial standpoint, is a more economical proposal for Dayton than for Columbus. For both it is a matter of such vital importance that the necessary steps, as indicated by the engineers, should be undertaken at once.

Engineers and the Public Good Until engineers "speak out in meeting" they cannot expect to be accorded the recognition needed for the exercise of that influence which is so necessary for proper control in the administration of engineering works. Innumerable opportunities lie about, but are not grasped. Recently in Vancouver, B. C., at a meeting consisting largely of engineers, the local representative in the Dominion Parliament reviewed briefly a list of staggering figures covering certain Government projects under way in British Columbia. Later in the evening Mr. G. R. G. Conway pointed out that there was no engineer on the board which had apportioned these millions for engineering work; to which the Parliament member retorted that engineers were not needed on the board, as they could be employed when required. This evoked a broadside from Mr. Conway in the form of a convincing argument showing that the engineer should have a place and a voice in the control of public affairs. So long as engineers are limited by being "employed" merely to plan the details and to carry out the wishes of boards just so long will there be no reflection of the best engineering talent in the scheme of Federal and municipal expenditures for engineering work. This same suggestion—that the engineer be given a voice in administrative matters—has been heard in Seattle recently in connection with the appointment of a charter revision committee. Discussion in local engineering circles, anticipating some modified form of control by commission, shows a strong desire to see an able engineer on the commission or controlling body. The way to make a beginning, however, is not to hope that the committee will make proper provision for the engineer but to influence the mayor to appoint several engineers on the revision committee. Out of fifteen members, three might well be engineers. This was the plan followed at Detroit, and in consequence the charter soon to be presented to the people provides for a radical reorganization of the engineering departments, showing plainly the influence of the engineering members of the committee. The adage, "The Lord helps them who help themselves" is truly applicable to engineers and engineering bodies. If they insist upon waiting till they are asked to help they will probably never participate in public affairs. The Cleveland Engineering Society, fully realizing this, helped itself—took the initiative—and now its aid is sought when public questions involve engineering matters.

Concrete-Slab Bridges On account of their unusual length the design of the Bush and Gunpowder River bridges on the Pennsylvania Railroad has excited much interest. This is not due to any particular novelty of the design, for structures of a similar character, but not so long, have been built on Western railroads. The Pennsylvania, however, is well known for the "progressive conservatism" of its designs, and for that reason the article on page 400, supplementing one published some time ago in this journal, will be found of interest. There were no restrictions imposed by navigation, but the character of the bottom—soft material—was an important factor. Of the three types considered concrete arches were rejected on account of their cost and the danger from settlement, while the decision as between solid concrete slabs and deck plate girders with concrete floors was made on the ground of the greater economy. This is the more interesting because of the higher foundation cost with concrete slabs, their maximum length being assumed as 30 ft. In the final design, moreover, it was found economical to decrease the length to 26 ft. The span dimensions having been determined, the design of the slabs was simple and rational. The transverse distribution of concentrated loads was arbitrarily assumed and the slabs were constructed as solid rectangular girders proportioned for very heavy locomotive loads and reinforced for both tension and compression, with conservative unit stresses for both steel and concrete.

Road Congress a Success The Third American Road Congress, held in Detroit last week, brought together the most distinguished body of road specialists in American highway annals. It was a remarkable tribute to the energetic publicity methods of the secretary, Mr. Pennybacker, and the assistant to the president, Mr. Light. As was to be expected, there was a goodly spread-eagle delegation, ever ready to spout about Federal aid, national roads and the great highways in their sections of the country. But while ubiquitous, they were far outnumbered by highway officials and engineers who came there with a serious purpose. Few if any of the State highway engineers were missing. The Far West was well represented, and Canada sent a large delegation. The total registration was about 3600. The meetings, on the whole, were well attended, though toward the end the wear and tear of the week began to tell. A strong program committee should be able to discourage a lot of the elementary stuff presented at the congress and thus reduce the number of meetings. A congress starting on Tuesday morning and ending Friday afternoon could, if the program were well prepared and the papers distributed two weeks in advance, cover the same general ground as at Detroit, and with even greater satisfaction. The exhibit was excellent and, judging from the opinions gathered by the representatives of this journal, was as satisfactory to the manufacturers as to the visitors. There was some complaint that the equipment buyers—or at least the contractors—were not as well represented as could be desired; but this complaint was not general. The engineers and officials, several exhibitors emphasized, were most intelligent and satisfactory visitors. It is regrettable, however, that a meeting so successful in other particulars should have ended in a fiasco that could not do otherwise than leave a bad taste in the mouth. The Friday evening session on "Concrete Roads"—in which interest ran high because of the practical concrete-road demonstration around Detroit—and the resolutions scheduled for consideration on Saturday morning were unexpectedly and without notice anticipated and disposed of on Friday afternoon instead. How the officers of the congress should have so far forgotten themselves is difficult to imagine. Some of the visitors had made sacrifices to stay for these sessions and on learning (only after the Friday afternoon session) of the change left in disgust. Friday evening a few faithful but uninformed delegates and visitors gathered in the convention hall and sat around till their patience was exhausted. Among them was a party of highway officials from Windsor and vicinity who had been especially invited, so they stated, to hear the paper on concrete roads. With this exception the congress was a decided success.

Road Congress Resolutions To those present at the Road Congress the character of the resolutions is in general what might have been expected, though in one particular a note of conservatism is shown that was not indicated in the discussions of the congress. This particular—heartily to be commended—is the request that the Federal Congress authorize the appointment of a commission to make a thorough report on and recommend a system of Federal aid. Had the members of the resolutions committee been guided solely by the temper of the delegates and not consulted their own sound sense they would have declared for an immediate and generous Federal-aid measure. Federal aid seems inevitable. It is desirable, therefore, that the subject be studied by an impartial, non-political commission, in order that sanity may rule. The dangers in Federal-aid measures, as Secretary Houston pointed out in his address to the congress, are many and haste should be made slowly. Hearty endorsement can be given, too, to the resolution favoring official representation by the United States in the International Road Congress. Sincere friends of the good-roads movement will regret, however, the support given by the congress to the national highways scheme. It is unlikely that such a plan can immediately be protected with safeguards which a generation has been unable to discover for the public buildings and the rivers and harbors bills. The best way to prevent the passage of sane Federal-aid measures is to turn the national highways plan into the Federal Congress and make it the instrument of vote trading. The fighting over routes will probably bring about press criticism that will be a serious obstacle when the latter measures for Federal aid are brought up. Those who feel that of the two plans—national highways and Federal aid—the latter is the less objectionable will do well, despite the congress resolution, to continue their opposition to the former plan. In the end, the Engineering Record believes, they will be found to be better friends of the good-roads movement.

Concreting in Cold Weather

It is none too soon to start preaching against the dangers of careless work in winter concreting. Despite the emphasis placed on the subject there has been a harvest of disasters each winter, serious always in the financial loss, and sometimes in life. Without doubt the dangers are now appreciated by a greater number of contractors and inspectors than ever before, but the increase in the number of users of cement seems to have exceeded the spread of sound knowledge of its use. The recruits and the older users who, fortunately, may have escaped disasters through luck rather than intelligent care form a large enough body to appall even the most enthusiastic campaigner.

Fortunately, there is promise of help in many quarters. The Universal Portland Cement Company has recently issued a third edition of its pamphlet, "Concreting in Cold Weather," most valuable for contractors, foremen and inspectors. Other cement companies also are preparing literature, and at least one company will use its advertising space in technical and contracting papers to preach sound doctrine on cold weather concreting. There cannot be too much co-operation. The cement companies owe it to their industry to make each salesman a missionary to warn against the dangers and teach the precautions necessary. Special efforts, more strenuous even than those of recent years, should be made to enlist the help of the jobber.

Engineers and architects have a responsibility no less serious than that of the cement companies. In fact, this journal has repeatedly taken the stand that, as technical directors of the work, they should be held criminally liable for accidents resulting from inadequate precautions against freezing. Building departments, of course, share this responsibility and should exercise the closest supervision over concrete work within their jurisdictions.

The precautions necessary, moreover, are so simple that there is no excuse for not applying them. To discourage concreting altogether in cold weather is not only unnecessary but would result in tying up to no good purpose the capital invested in construction plant and in losses owing to postponement of the use of the structures. There are construction difficulties in other lines, but they are not allowed to interfere with the execution of the work. The heating of the material and the protection of the fresh concrete from freezing are sufficient measures to permit work to proceed in all but the very coldest weather. With intelligent supervision and close attention to the heating equipment there is no reason why even in zero weather pouring should not be continued.

The use of salt, however, is open to objection in reinforced structures, and while apparently not harmful in plain concrete should not be used where steel is embedded. It has limitations, moreover, as to influence, its effectiveness being practically nil at a point 10 deg. below freezing.

Persistent efforts, beginning at once, may help in lowering materially the disaster record made last winter. Cement manufacturers and their salesmen, cement jobbers, building department officials, engineers, architects and contractors experienced in cold-weather work can all bear a part in the educational campaign. The reward will come in greater confidence in concrete as a construction material and in the saving in life and property.

Flood Damage

After the numerous disastrous floods of the present year there is naturally a great increase in the discussion of flood control. It seems clear that as years go on the damage increases. There are many who believe that the floods are growing greater owing to the clearing of forests, the increase in agricultural drainage, and other conditions resulting from the occupation of the land by man. On the other hand, the best evidence available indicates that even before the country was occupied by white men floods occurred that were as great as those of recent years.

At any rate, the great increase in the amount of damage from floods in the last few years has been occasioned primarily by the increased occupation of areas that are sometimes flooded rather than by an increase in the volume of the flood flows.

The land along any river may be divided into three classes—(1) the river channel, which all agree ought not to be encroached upon; (2) high land above all floods; and (3) the middle land, usually dry, but sometimes flooded.

The paper to be presented by Mr. W. E. Fuller at the New Orleans meeting of the American Society of Civil Engineers, in discussing the problem of floods and the probability of their recurrence, brings home the fact that there is no such thing as a maximum flood. Instead there is a succession of floods of ever-varying size. There is a flood of such a size that it may be expected to occur every year. There is a much greater flood that may be expected to occur once in ten years; a still greater one to be expected once in a century; and it may be assumed that there will be still greater ones that occur only at intervals of several centuries or more.

It would, theoretically, be possible to draw a line along the bank of a stream above which there would be only one chance in ten that the water would rise in any one year; and to draw another higher line above which there would be only one chance in one hundred, and so on. These imaginary lines may be referred to as the ten-year flood line, the hundred-year flood line, the thousand-year flood line, etc. If they could be marked across the landscape so that all would see much of the loss by floods would disappear, because the people would protect themselves.

The first settlers in any community are apt to be cautious and to locate on high ground. As communities increase in size the high land, safe from flood conditions, becomes more valuable than the low land. Knowledge of flood conditions is lacking and memories are short. Low lands convenient for manufacturing purposes or suitable for residences are tempting to those who lack capital to secure better sites, and especially to those who have not the foresight to see the damage that will sooner or later result. The town originally built above the hundred-year flood line gradually extends down to the thirty-year and to the ten-year line.

It cannot be held, of course, that this whole middle area, especially where it is large, should be reserved. Some of it can be reclaimed by filling to a higher and safer level, and when the advantage of the location is great and business can be so conducted that damage by flooding will be limited it will pay to take the risks of a site that will be flooded from time to time.

But it must be recognized that it is the increasing use of land in the middle, or flood zone, for business and residence purposes that is responsible for the great increase in loss from floods.

The occupation of this middle zone has an indirect influence in increasing the height of floods resulting from a given flood discharge. Highways, trolley lines and railroads are built across the flood plain, leaving channel passages large enough to carry only ordinary floods. In extreme floods the water still passes, but with a loss of head in the passage that means an increased water level in the reach above. Warehouses, factories and fences in the flood areas add resistance to the passing water. One such structure may have little influence, but when the number is increased until additional points of resistance are presented to the flowing water all the way the aggregate effect is to make the water rise considerably higher than it otherwise would have done, and to increase the resulting damage.

One of the very simple remedies, at least in its obviousness, relates to the prevention of flood damage, but not to the control of flood flows. It consists simply in refraining from occupying land that is sure to be periodically flooded. It may not be practicable to do this in all cases, but along many rivers there are ample sites for all the business that needs to be accommodated on land above the danger mark.

Lands that are ordinarily dry but which sometimes are submerged need not become waste lands. There are uses to which they may be put. In cities they are most appropriately used for park purposes, for parks can be built and maintained so as not to interfere with the occasional use of the full flood channel. They will occasionally be damaged more or less by floods, but the damage will be relatively small and easily repaired. What an improvement it would be if cities now built in part in the flood plain of a river could be moved back on higher ground, and the river bank and the lower part of the occasionally flooded area laid out as a public park with ample roads and drives! Arrangements of this general character are found in some European cities and give them a charm which appeals even to travelers who may be utterly oblivious to the utilitarian value of the improvement. Without a doubt this scheme is receiving careful consideration where flood-prevention studies are in progress. Its cost generally will be prohibitive in closely built up cities, but its logic is so forcible that it ought to go into flood-prevention legislation as a safeguard against the repetition by new communities of the errors of the old.

High-Pressure Gas Lighting

High-pressure gas lighting has spread so rapidly abroad that surprise has been expressed that there has not been some progress here. A number of conditions, to be referred to later, are responsible for the unpopularity of the system in America, though undoubtedly plain inertia accounts to some extent for the neglect.

In the high-pressure scheme the pressure of the gas is raised from the normal of about 1.5 oz. to 2 lb. As a result, the temperature of the flame at the mantle is raised and the products of combustion are forced out more rapidly, resulting in an increase in efficiency—so far as volume of gas burned is concerned—of from 40 to as much as 100 per cent, depending on the lamp and the quality of gas. The reason for this great increase in efficiency can readily be appreciated from the fact that the light emitted by a mantle varies as the twelfth power of the absolute temperature.

The system naturally went through the usual stage of development and was placed on its present successful footing with the advent of the inverted type of mantle. Since 1907 its progress in application has been marvelous in England, Germany and France. Following its successful use in a large portion of the grounds of the Franco-British Exposition in London in 1908 came the rapid extension of the system for street lighting in various parts of London, until now a large part of the city of London proper is so lighted, as well as many important thoroughfares and squares.

Factory owners and commercial interests in England, moreover, have not been slow to recognize its advantages, its use by the former undoubtedly having been influenced by the industrial applications in which high-pressure gas is productive of special economies. In Birmingham a large high-pressure main has been put down, distributing gas over a large area at a pressure of 15 lb. per square inch, and while laid mainly for industrial purposes advantage is taken of it for high-pressure gas lighting, using the necessary reducing valves.

In Germany the progress has been only little slower than in England. In the city of Berlin, for example, there are not less than 40 miles of streets lighted by the new method. Quite a number of other cities in Germany are using the system, and in at least one of them a variation has been adopted of supplying the gas at normal pressure, but of feeding compressed air to the burner. Apparently the latter scheme is proving satisfactory, though data permitting of a comparison with the usual method are not available.

In the United States applications have been limited to experimental installations—some six or eight in number—at the offices of gas companies.

The first cost of high-pressure lighting when gas is obtained—as it generally is in such installations—from a plant supplying domestic and other services at ordinary pressures is obviously an item of considerable importance. Not only are the lamps of special construction, but compressors must be installed, special devices or tanks supplied for preventing fluctuations from the compressor reaching the lamps, and separate piping run. Where the system has gained such popularity that a high-pressure main from the gas plant is warranted the system is much simplified. The general method of supplying the gas is to install a separate compressor for each group, the division into groups being based on the obvious factors of number and proximity of lights, cost of laying piping, etc. In London many shop fronts are lighted from such isolated systems, the consumer paying a fixed charge for the service, the lighting and extinguishing of the lamps being entirely in the hands of the gas company.

In the maintenance cost, too, high-pressure lighting is more expensive than low pressure, so that under any given set of conditions the saving in operation must be carefully compared with the increased installation and maintenance costs. Often the two practically balance. The more expensive the gas, the more likely is the high-pressure scheme to prove economical.

These factors have had the careful consideration of gas companies in the United States, and if their actions are properly interpreted the high-pressure system has shown little, if any, advantage over the older. With the competition gas lighting has been, and is, receiving from electricity it is safe to expect that future developments in high-pressure lighting will promptly be taken up if the saving over the present low-pressure lamp is at all material.

Synthetic Stone

Hitherto the word synthetic has savored of the smells of the chemical laboratory and has perforce summoned up visions of the alembic, the crucible and the beaker. The successes of chemists in producing by long and painstaking experimentation substances which had formerly been thought creatable only by processes of Nature have justly had wide publicity. Synthesis, therefore, has been acquiring a strong chemical affinity. But a few engineers and manufacturers of building materials have been steadily developing and perfecting a material which, because of its excellence, should be distinguished in name from concrete, to which it is related as to its ingredients. Synthetic stone is a fitting designation for it.

For approximately twenty years concrete made with special care or by unusual processes has been on the market in this country under such indefinite and confusing names as artificial stone, cast stone, concrete stone, granite composite and imitation limestone. Partly because of such misleading names the material has been confounded with concrete blocks, so heartily despised in certain quarters, and with cast-in-place concrete, but little better liked for architectural construction in others. But a few concerns, at least, have for a number of years been producing stone which for appearance, strength and other qualities compares favorably with good limestone, sandstone and granite.

In some particulars the synthetic stone has advantages over the natural. It has not the same limitations as to sizes and shapes and is much less subject to damage by fire. It is less expensive, for if a pattern is repeated there is a material saving which cannot be secured with cut natural stone. Intricate shapes can be made with relatively less increase in cost than in natural stone, the material is less subject to some kinds of stain, while some injuries can be perfectly repaired, which, if suffered in a natural stone, would be hopeless. It can be, and usually is, reinforced with steel according to the uses and shapes of the blocks, and by this means many unsightly cracks, which often occur in lintels and similar members of natural stone, are avoided. It can be cast in the shop and transported after finishing—the more common practice—or cast in place in the building and finished subsequent to the operations which might soil or deface the walls. In some instances savings can be effected in transportation charges because the stones can be made thinner, or because less waste or surplus material is required.

Surfaces of synthetic stone can be tooled in almost, if not quite every way that the surfaces of natural stones can be tooled; moreover, there are certain special treatments not applicable to natural stone. In texture and color many natural stones can be so closely simulated that a close inspection, even by persons familiar with such materials, is necessary to differentiate the artificial from the natural product. Tales are told of architects who have specified natural granites to match existing synthetic stone, all unsuspecting the nature of the earlier material. In addition, effects in color, texture and finish can be obtained which are not practicable with the natural stones. On the other hand, there are certain indescribable accidental variations of tone and texture in some kinds of the natural product which are beautiful and desirable but which, up to the present time, the most skilful manufacturers of synthetic stone have been unable to reproduce or equal.

In density, strength and freedom from absorption results are constantly attained which command respect. Weights of 140 to 155 lb. per cubic foot testify to the density; compressive strengths of 6,000 to 10,000 lb. per square inch have been shown by tests; absorption as low as 4 per cent by weight in forty-eight hours can be specified, and as low as 1 per cent at the age of twenty-four months is claimed. Its durability is attested by examples which for nearly twenty years have resisted weather and wear under severe conditions. Side by side with granite, in steps, sills and trimmings, some of the best synthetic stone has endured equally well, at least so far as surface inspection can determine.

Unfortunately, however, the record has not been uniformly good for all material for which places in this class have been claimed by makers or sales agents. Some have been distinctly inferior in materials and workmanship, and consequently disappointing in appearance and durability. Possibly stone of such quality has been good enough for less expensive buildings, and its price may have been sufficiently low to compensate for its inferiority. Some examples closely approach common concrete and give to the beholder the unpleasant impression usually conveyed by an evident and unsuccessful imitation.

Having observed that not a few engineers and architects were uninformed as to this useful building material and its possibilities, it has seemed worth while to bring it to their attention. Doubtless, many men of both professions have repeatedly passed excellent examples of synthetic stone in more or less prominent structures in many cities and towns without having once suspected that it was not natural stone. Those who, having heard of it, instinctively think of its cost in figures which they have grown accustomed to apply to common concrete will soon be disillusioned when they attempt to buy it. But when the saving as compared with natural stone is considered, or when it is recognized that the desirable qualities of stone can be secured for edifices for which the expense of natural stone is prohibitive, the claims for economy in the use of synthetic stone are justified. Before specifying it, however, the engineer or architect should learn the details of manufacture, so that he may not unwittingly increase the cost to no useful purpose.

White Salmon River Power Development

Medium-Head Hydroelectric Station in the State of Washington Served by a Wood-Stave-Pipe Line 13.5 Feet in Diameter and 5070 Feet Long

By R. M. Overstreet, Seattle, Washington

The Northwestern Electric Company's power development, which has just been completed by the Stone & Webster Engineering Corporation, is situated about 75 miles from Portland, Ore., on the White Salmon River, about 4 miles from its confluence with the Columbia River. The Northwestern Electric Company was granted a franchise by the city of Portland in 1912 for a light and power system in that city, and this plant is the first unit of a series of developments which will be necessary from time to time to supply the increasing demand for power and light in Portland and the smaller towns in the vicinity. The preliminary development, selection of site and general plans for the plant were worked out by Mr. B. C. Condit, chief engineer of the Northwestern Electric Company at Portland. The detail plans and construction were handled by the Stone & Webster Engineering Corporation.

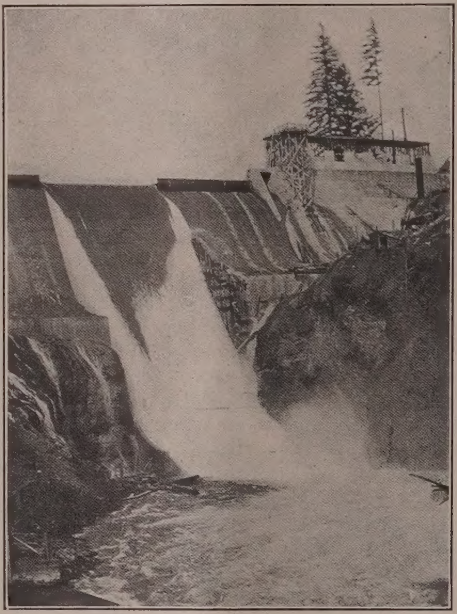
The White Salmon River rises at the base of Mount Adams, in Washington, and flows in a southerly direction to its junction with the Columbia River at Underwood, Wash., and drains a watershed above the dam 350 sq. miles in area. The flow of the stream as determined from the reports of the Government and those of the older settlers varies from 600 to 6000 sec.-ft., with an average of 1250 sec.-ft. The grade of the river from the dam site to the power house, about 6000 ft., is slightly more than 1 per cent. The ponding capacity behind the dam is 40,000,000 cu. ft., and water is backed up the stream for 2½ miles.

Dam and Appurtenances

The dam, which is of the solid-masonry gravity type, is 472 ft. long, 125 ft. high, and contains 29,620 cu. yd. of concrete mixed in proportions of 1 part cement, 3 parts sand, and 5 parts crushed rock. In addition to this concrete there are 68,000 lb. steel in racks and frames and 80,260 lb. of reinforcing steel. The spillway section, 232 ft. long, is provided with 5-ft. flashboards, designed to let go in several different sections. There is a 6-ft. log sluice and a fishway. The outlet consists of two 5 ft. 6 in. wood-stave pipes running through the dam at El. 180.75. These outlets are controlled by two 5-ft. sluicegates whose stems run diagonally on the upstream face of the dam and into the gate house. The site of the dam is in a narrow rock gorge in the river, with banks rising rather abruptly from the top of the canyon, which is about 60 ft. deep. Very little excavation was needed to strip the bed to solid rock.

The intake for the 13 ft. 6 in. pipe line consists of five 8 x 9 ft. intake gates. These gates are operated from the gate house on top of the dam and are controlled by a 10-hp. electric motor or by a 9-hp. gas-engine auxiliary.

Work on the plant was started May 15, 1912; and the first current went through the transmission line on April 26, 1913. From 900 to 1000 men were employed on the work, and 80 teams were used in hauling material over a specially constructed road from Underwood.



Downstream View of Dam

During construction the flow of the river was diverted through a 12½ x 7 ft. timber flume, running through three rock tunnels. In preparing the site 19,150 cu. yd. of material were moved, 14,500 cu. yd. of which were sluiced off with a stream of water through a 22-in. giant under 170 lb. pressure. The remainder was moved with a Bagley scraper.

Construction Plant

On the west side of the river, at an elevation of about 320 ft. above the dam crest, a rock quarry was opened up. An Allis-Chalmers No. 6 crusher, driven by a 75-hp motor, with a daily capacity of 300 cu. yd., crushed the rock used in the concrete. From the crusher the rock was delivered by gravity into a Jeffrey mill, then through the separators, where the small fracture was delivered to sand rolls and the larger size into the rock bins. Two No. 14 Smith 1 yd. mixers, driven by 20-hp motors, were used, the maximum output being 10,000 cu. yd. in one month of ten-hour shifts.

A temporary 300-hp generating plant was installed at the end of the diversion flume. This plant furnished all power required for construction purposes.

One 2-in. cableway, 775 ft. long, and one 1-in. auxiliary cable 995 ft. long, were used in placing material, although about 80 per cent of the concrete was placed by gravity from the mixers.

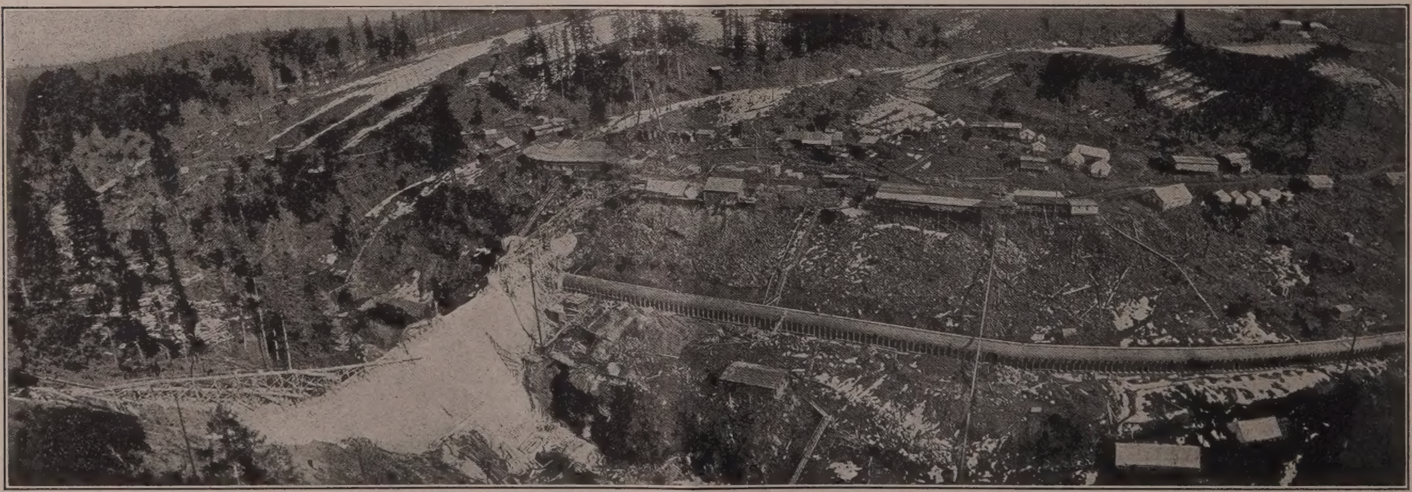
A temporary sawmill with a daily capacity of 30,000 ft. b. m. was installed at the camp for cutting form material and cradles for the pipe line.

Wood-Stave-Pipe Line

A feature of the plant is a wood-stave pipe, 13½ ft. in diameter and 5070 ft. long. This is the largest wood-stave pipe ever constructed. It was manufactured and erected by the Pacific Coast Pipe Company of Seattle, Wash. The staves for the line were cut from Douglas fir, the material in the rough being 4⅜ x 6 in. cut and dressed to a finished dimension of 4 x 5⅝ in. There are ninety-four staves in the complete circumference of the pipe, or 205.6 ft. b. m. per linear foot of pipe.

The specifications on the pipe were as follows: "Pipe to be of Douglas fir, staves to be planed to true circular outline of the pipe inside and out, to be of uniform thickness and each stave to be of uniform width throughout its entire length. Edges to be dressed to true radial lines. All dimensions to be such that when pipe is fully cinched up it will form a true circle of proper diameter. Edges must touch along full length and width in such a manner as to make perfect joints. At least 80 per cent of staves to be 12 ft. long or over."

The average length of staves in the line

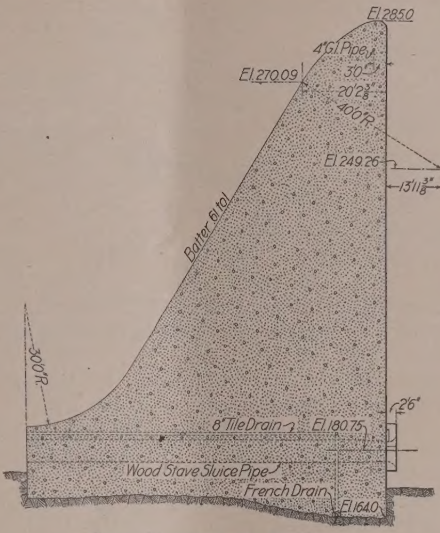


Headworks of the White Salmon River Hydroelectric Development at a Late Stage of the Construction Period as constructed was 20 ft. and the maximum 32 ft.

In preparing the grade for the pipe line, which was all sidehill location, 91,000 cu. yd. of excavation were done by steam shovel, 6000 cu. yd. by Bagley scraper and 18,000 cu. yd. by hand. The line was laid on a grade of 1½ ft. per 1000, and was supported on timber cradles placed 4½ ft. on centers, resting on a bed of seven 6 x 12-in. sleepers running longitudinally with the pipe. Two ¾-in. truss rods on each cradle, slung under the pipe line, served to prevent the cradles from spreading longitudinally. Material for the pipe was hauled by team over a wagon road from Underwood, 4 miles down the river, taken from wagons, lowered on the grade by cableways and distributed along the line by dinkey engines and cars of 2-ft. gage.

Of the total length of line 47 per cent was on tangent, and the remainder on curve. The sharpest curve had a radius of 789 ft. and was 391 ft. long. The cradles were all located and secured on true center line, and the pipe was built in the cradles. No difficulty was experienced in making the curves and the finished line presents a very regular appearance. A footwalk on top of the pipe is provided from the dam to forebay, and gates are placed in the line every 500 ft. to permit of hose connections for sluicing out the drains along the side of the pipe.

Work on the pipe construction was started in December, 1912, at which time there were about 40 in. of snow on the ground. The construction of the line was carried on with a crew of eighteen men, divided into two gangs. One gang handled material, placed cradles, built pipe and put on bands. The other crew spaced the bands and completed the cinching. Water was turned into the line on March 21, 1913, and since that date has never been turned out of the line. With the exception of the tightening up of a few of the bands, no work has been necessary on the line since its completion.



Cross-Section of Spillway

Pipe Bands and Joints

The staves in the line were not beaded but were finished to the true radial lines of the pipe. Butt joints were made with No. 10 gage steel tongues 1¾ in. wide, cut ⅛ in. longer than the saw curve in the butt of the stave.

The head on the pipe line, assuming water surface behind the dam to be at El. 293, varies from 22.75 ft. at the intake to 30.5 ft. at the forebay measured to the center of the pipe. On account of the low head the banding on this line was rather light, consisting of two-piece ¾ in. bands, spaced from 8 to 6 3-16 in. center to center, except over the butt joints, where spacing was narrowed up to 6 in. center to center. All butt joints were kept within a space of 4 ft. around the pipe.

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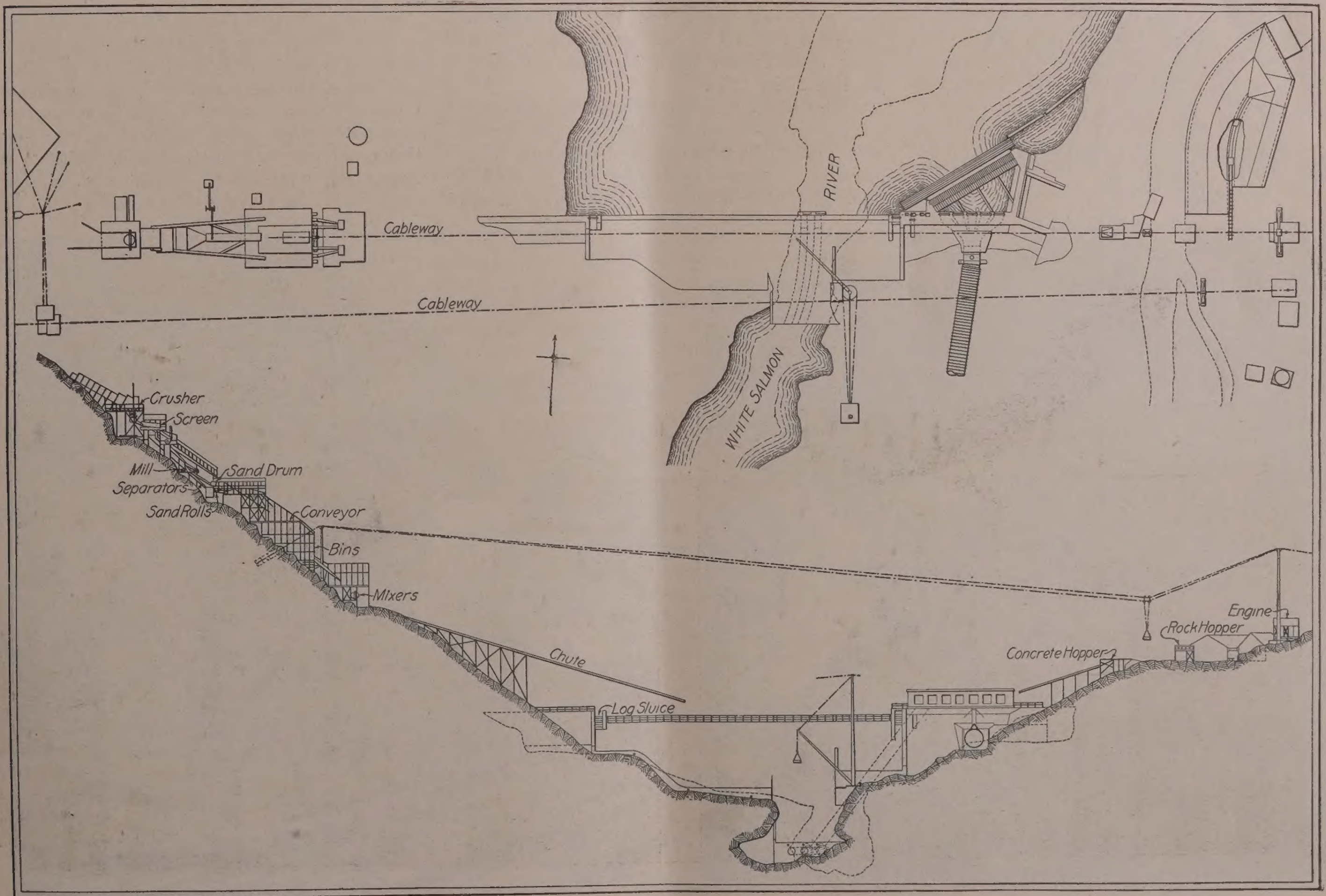
The life of the 13½-ft. pipe line is estimated by Mr. L. M. Grant, chief engineer of the Pacific Coast Pipe Company, to be about twenty years. It is believed that the pressure lines will last a lifetime. Friction loss is estimated at 0.94 ft. per 1000, with a velocity of 8.5 ft. per second, using the value of 0.012 in Kutter's formula.

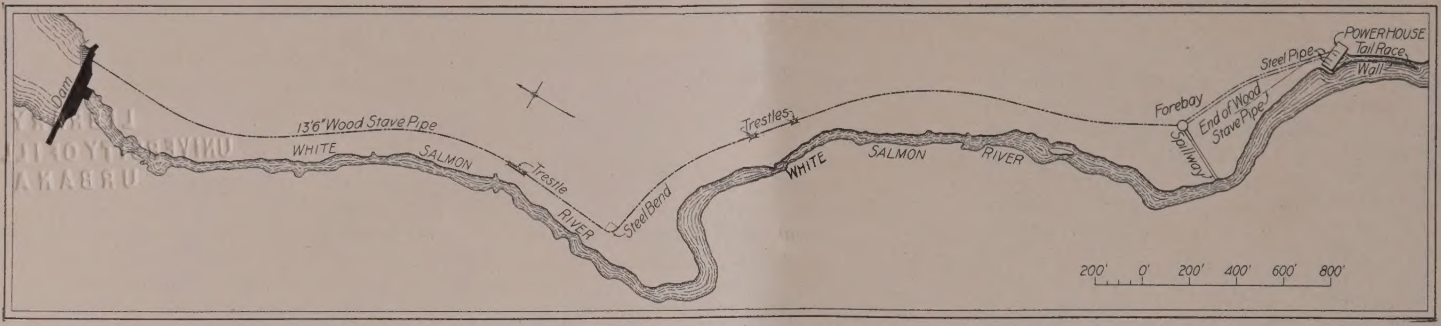
At one point on the line it was necessary to make a sharp bend of 83 deg. for a length of 58 ft. On account of this degree of curvature a steel bend was put in and anchored in a block of concrete. This bend is made of ⅜ in. steel, and weighs 51,200 lb.

A concrete forebay at the end of the pipe line serves to equalize the flow into two 9-ft. penstocks, and to relieve the surge due to sudden closing of the turbine gates, as well as to supply surplus water when the gates are opened. This forebay is 41 ft. high, and 40 ft. in diameter, with reinforced concrete walls 1 ft. 10 in. thick. In the construction of this forebay of concrete 82,400 lb. of reinforcing steel were used. The connection of 13½ ft. pipe, with the two 9 ft. penstocks is made through the forebay in a reinforced concrete wye. At the top of this wye is an opening 7 ft. long, which allows the water to flow into the forebay. The penstocks are provided with gates at the forebay, operated by two 10 hp motors.

A 12 x 4 ft. concrete spillway is provided at El. 290, which also is the elevation at the top of the flashboards on the dam. This over-



Plan and Elevation of Headworks, Showing General Arrangement of Construction Plant



General Plan of White Salmon River Hydroelectric Plant, Showing Location of Long Pipe Line

flow drops to the bottom of the forebay into a concrete flume, from which it discharges into the river.

The two 9-ft. pressure lines from the forebay to the steel penstocks at the power house are of wood-stave construction, having sixty-four 3⅝ in. staves to the complete circumference of the pipe. The same specifications for staves apply here as on the larger line. From the forebay to a point where the head reaches 46 ft. the banding consists of ¾ in. two-piece bands, the spacing varying from 8¾ to 6¾ in. center to center. From this point on ⅞-in. bands are used, the spacing varying from 8⅝ to 2½ in. at the end of the pipe, where the head reaches 158.5 ft.

Penstocks

The penstocks are supported on concrete cradles spaced 30 ft. center to center. Between the cradles the pipe is ballasted with crushed rock up to the horizontal diameter of the pipe.

The maximum grade on the twin 9-ft. lines is 23.8 per cent. There is one curve with a radius of 573.7 ft. for a distance of 160 ft. At the center of this curve the lines are anchored with a heavy block of concrete.

From the ends of the two 9-ft. wood stave lines the water is carried in ½-in. steel penstocks to the power house, where each penstock divides into two 6 ft. 4 in. lines of ⅜ in. steel, reducing at the turbines to 5½-ft. diameter. The weight of steel in pressure lines is 165,900 lb.

The power house is of concrete and steel-frame construction, 120 ft. long by 55½ ft. wide, and is provided with a 40-ton crane.

The tailrace is 400 ft. long, concrete lined for 140 ft., and the flow of the river is kept out by a concrete retaining wall.

The power-generating equipment, which was supplied and installed by the Allis-Chalmers Company, consists of two double overhung, horizontal, spiral case, Francis turbines of 9000 maximum brake-horsepower at 160 ft. net head, direct-connected to two 6000-kw Allis-Chalmers alternating current generators.

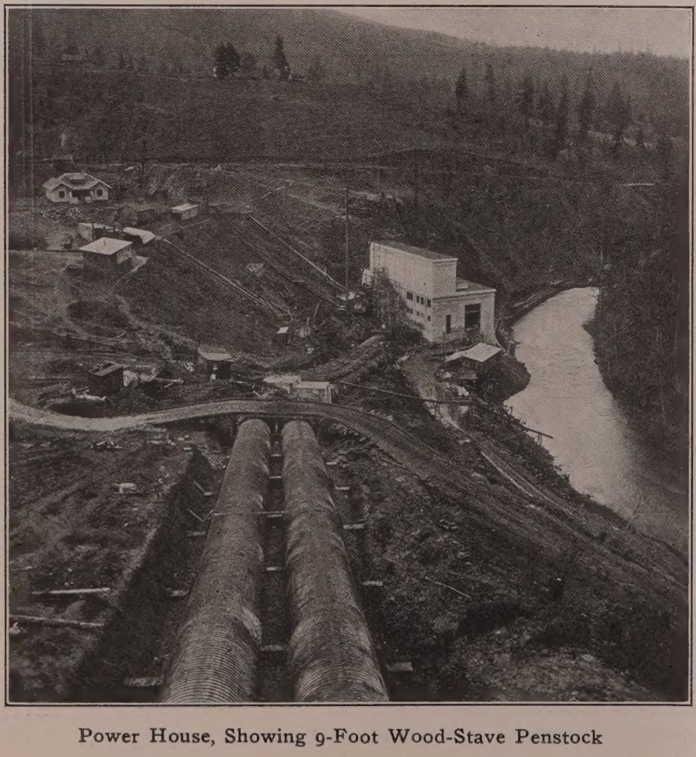
The runners of the turbines are carried one on each side of the main generator and are overhung on its shaft. Each runner has a separate discharge and can be operated independent of the other, making two prime movers for each generator unit. Previous to this, which is the first unit of this type ever installed, it had been customary in building twin turbines, with runners incased in cast-iron spiral casings, to provide a common discharge for the two runners. The advantages gained with the new design are elimination of losses due to the two runners discharging into a single draft tube, the decreased floor space necessary owing to the decreased length of turbine and generator shaft and the flexibility of operation secured by the possibility of operating each runner as a separate unit independent of its twin.

Each turbine is so constructed that all parts are removable without disturbing the generator. The makers guarantee the turbines when properly set up and adjusted to deliver not less than 9000 brake-horsepower maximum at the turbine coupling when operating at a speed of 360 r.p.m. under a head of 160 ft.

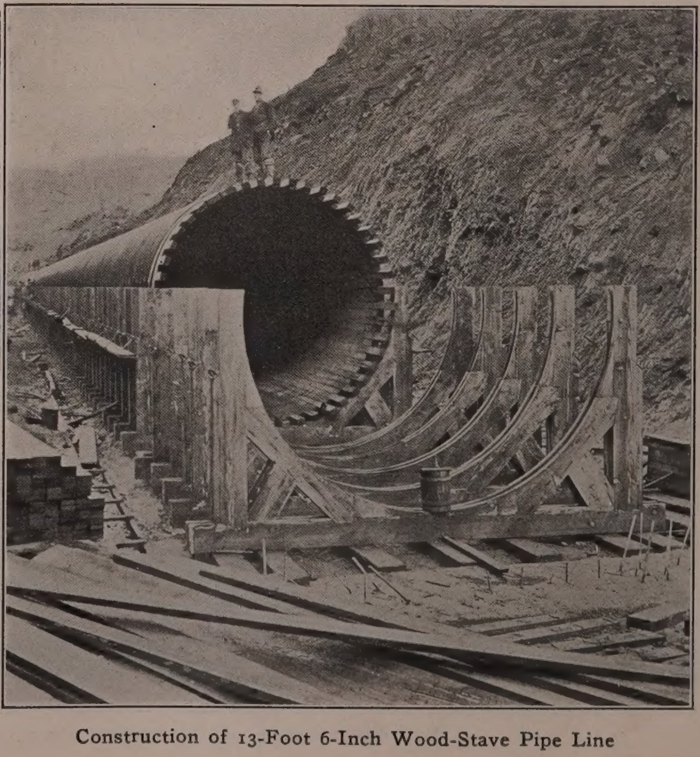
Owing to the long pipe line and relatively small capacity of the forebay, the regulating conditions for this plant were rather difficult, and it was necessary to provide a governor, designed especially for the pipe line and forebay conditions and operating in connection with the governor pressure regulator. The long line and small forebay capacity increase the constant surge tendency due to fluctuation of load. This fluctuation in turn causes a rise and fall in the forebay level, making a variation in head on the turbine and causes the governors to continuously readjust the gates, which is apt to result in "hunting" of the governors. With the type of governor installed, however, this "hunting" tendency has practically been eliminated.

The generators are guaranteed to operate twenty-four hours at 2300 volts, 1505 amperes at terminal and 80 to 100 per cent power factor, with a rise in temperature not to exceed 40 deg. C. At 25 per cent greater current for two hours following the above twenty-four hours' run the temperature rise is not to exceed 55 deg. C.

The current from the generators is stepped up on two three-phase transformers to 66,000 volts and is transmitted to Portland, 70 miles away, on steel core aluminum wire equivalent to No. 3 copper wire. The line is strung on wood poles along the north bank of the Columbia River to Camas, Wash., where it crosses the river to the south side on five steel towers, the maximum span being 1200 ft.



Power House, Showing 9-Foot Wood-Stave Penstock



Construction of 13-Foot 6-Inch Wood-Stave Pipe Line

Flood Protection for Dayton

Abstract of Preliminary Report; Final Decision Is Reserved, but the Advantages of Co-operation among Communities Are Strongly Urged

After several months' work on surveys a preliminary report was made last week by the Morgan Engineering Company, of Memphis, to the Flood Prevention Committee, a sub-organization of the Dayton Citizens' Relief Commission, outlining the possible methods of flood protection for Dayton and other cities and towns of the Miami valley.

While the surveys and studies that are being made by the commission's engineers are not far enough advanced to give detailed estimates of the probable cost of the various projects, they have revealed that the method of flood control by reservoirs is particularly adaptable in this instance. At the time of undertaking the survey the engineers did not consider reservoir construction feasible for this locality. A search for reservoir sites was made largely because of the policy of investigating every possible means for improvement before becoming committed to any particular one. It has been a distinct surprise to them to find how perfect may be the control of the floods by means of a system of reservoirs.

As much of the value of the reservoir system from Dayton's standpoint depends on the co-operation extended by the cities and towns of the Miami valley that were affected by the flood of last March, it was thought best to give full publicity to the progress of the work and the possibilities that have been uncovered, even though it is yet too soon to give a cost analysis.

The preliminary report outlines eight possible methods of flood control, seven of them being local protective works and stream diversions, two of which include two reservoirs on a tributary to the Miami to retain the floods on that particular stream. While the cost of any one of them would probably be less, at least not more, than the cost of the eighth method, involving six reservoirs, their effect would be purely local, and would, if anything, have a tendency to increase the flood height at points down the valley. It is evident, of course, that each town both above and below Dayton would be forced to provide its own protection—in some cases at an immense cost for levees and channel diversions.

There are any number of reasons, as the engineers' report shows, why the reservoir system for the Miami valley seems the best, but a possible drawback is the difficulty of securing unity of effort. The problems confronting a scheme of local channel improvement arise from the necessity of condemning densely built up city property from unavoidable interference with streets, railways and other public improvements, and from five concrete-arch bridges, each about 600 ft. long, which greatly contract the waterway of the Miami. To raise them would be a stupendous task; to destroy them would be to cast aside $700,000 worth of extremely serviceable property. With the bridge openings as they are at present, during such a flood as that of last March, a head of 20 ft. would be required to put the water through the bridges alone. The channel is very crooked and the loss of head due to the bends would amount to at least 10 ft. Dayton completely occupies a flood plain where four streams converge, and is surrounded by hills rising to a height of 200 ft., so there is no economic possibility of diverting the streams around the city.

Considerable publicity has been given an unauthorized statement originally published in a Dayton newspaper to the effect that reservoirs were not feasible and that the control of the floods would be accomplished for $8,000,000. While it is true that the preliminary estimates place the cost of local protection at from $7,000,000 to $10,000,000, at the present time the protection of the entire valley by reservoirs at a cost of about $12,000,000 seems the more likely plan.

Summary of Report

The chief features of the report follow:

The engineers were instructed to make surveys and to prepare plans for the protection from floods of the city of Dayton, and also of the cities of Miamisburg, Troy and Piqua, and all other towns in the watershed of the Miami River north of the south line of Montgomery County; and also to plan the reclamation of the agricultural lands in the valley of the Miami River and its tributaries.

The following projects are found to be feasible, though further investigations are necessary to determine fully their comparative merits and cost:

Plans 1 and 2 involve the building of two reservoirs on the Stillwater River and diversion channels within the city. Plan 3 contemplates diversion channels only.

Plan 4 provides for the removal of the concrete bridges and their replacement by steel trusses, with not more than two piers in the channel, while the fifth project would require the improvement of the river channels, leaving the concrete bridges in the channel, but deepening their foundations from 10 to 20 ft. While this method is believed feasible, plans have not yet been completed for deepening the piers.

The sixth scheme proposes the straightening of the Miami River channel by rounding off some of the sharpest bends, and at the same time increasing its size.

The seventh plan contemplates the raising of the levees. In the plans heretofore mentioned it is intended to keep the water line below the present tops of the levees. While this method of improvement seems to be feasible, it would have the disadvantages that street grades approaching the bridges would be steeper, that the higher stage of the water during a flood would tend to be a menace to the city, and that higher levees would be a detriment to adjoining property.

Of the foregoing plans those for the improvement of the present river channel are the most difficult to deal with at the outside of the bends in passing around the bends; of the necessity for paving the sides and part of the bottom of the channel with concrete to prevent the erosion which would result from high velocities, and especially the great loss of velocity at the bends in the river. In so crooked a river as the Miami, and with so high velocities as would be had, the loss of velocity due to bends in the channel is one of the controlling conditions. The engineering principles underlying this point have never been well worked out, but must be carefully investigated in plans for channel improvement. The report states that with the river channel improved, but not straightened, the water during extreme floods would be 10 to 15 ft. higher at the Herman Avenue bridge than it would be if the river were straight.

Plan 8 provides for storage reservoirs. The engineers state that due to the alternate widening and narrowing of the valleys of the Miami, Mad and Stillwater Rivers, they are peculiarly adapted to the construction of reservoirs. All of the more practicable sites over the watershed have been investigated and six have been found which fully meet the requirements.

If all the interests which are affected bear their fair proportions of the cost, flood protection for the Miami valley can be secured by a system of storage reservoirs more cheaply and more quickly than by any other method.

Cost of Reservoir System

The biggest item of cost in the system of storage reservoirs would be the land taken. As the reservoirs would be empty during the crop-growing season of each year, and as the ponding of the water during floods would tend to prevent soil erosion, and would cause fertile mud to be deposited, the productive value of the lands within the reservoir would probably be increased. However, as it may be necessary to purchase a large part of these lands in securing right-of-way, the engineers have included in their estimate of costs about half the total value of the lands below the water line during the most extreme floods, such as occurred last March. A large part of the lands in the reservoirs would not be covered once in 20 years.

It is estimated that with two reservoirs on the Stillwater River, two on the Miami, one on Loramie Creek and one on Mad River the extreme flood flow at Dayton would be reduced to not more than one-fifth, and at Hamilton, near the mouth of the Miami, to about one-third of the greatest flow during the March flood.

A system of reservoirs, the sole object of which would be complete flood prevention in the Miami Valley, would cost about $12,000,000. It is possible that a complete detailed estimate will show a considerably less cost, but such a possibility cannot be counted upon at present. If the National Government should co-operate toward a more extensive system in order to store water to raise the low stages of the Ohio River and to further reduce floods in the Ohio Valley, the cost would be increased.

In this estimate for reservoirs the engineers have considered only flood protection, and have not included parking or other improvements along the river in Dayton, or the cost of additional capacity of reservoirs for water power. In one instance it may be profitable to go to additional expense to develop water power. This would result also in the formation of a permanent lake near Dayton.

In view of the fact that the city of Dayton, as well as all other cities in the Miami valley, can secure protection most economically by co-operating in the construction of a system of storage reservoirs, the report states that it would be desirable for the Dayton committee at once to get in touch with the flood prevention committees in all parts of the valley to the end that such co-operation be secured. In the case of the small cities like Miamisburg, and in case of agricultural lands in the valley, this method would result in complete security at a moderate cost, whereas their condition is hopeless if they must rely on their own efforts for local protection.

Question of Design and Construction

In designing these reservoirs it seems desirable not to adhere closely to engineering practice in the construction of dams. The interests involved are so great that it is desirable to plan dams of heavier and larger section than is usual. The company's plans in this regard, the report states, may be criticised by engineers as unduly large and expensive, but it seems necessary that there should be left no room for doubt as to the absolute and complete security of such a system.

To protect the entire valley by means of reservoirs would require about half as much time as to protect Dayton alone by local works. Two to three years would be necessary to complete the construction of a reservoir system, after the legal proceedings make construction possible.

In view of the great amount of work involved in making accurate comparisons it will be some months before a final report on all methods of protection can be submitted. The investigations have gone far enough to indicate that the cost of protection to the city by local works will be not less than $7,000,000 nor more than $10,000,000.

Designing Concrete Slab Spans for a Railroad Bridge

The double-track bridges carrying the Philadelphia, Baltimore & Washington division of the Pennsylvania Railroad across the Bush and Gunpowder Rivers are located close together, are of exactly the same design, and are built under similar conditions, crossing inlets of the Chesapeake Bay where the water is very shallow and the bottom is of soft mud. Together they have 283 duplicate spans of 23 ft. 2 in. in the clear and eight similar spans a few inches longer, all of them made of single reinforced concrete slabs 28 ft. 4 in. wide and 34 in. deep, reinforced by about 14 tons of twisted steel tension and compression bars. The concrete is mixed 1:2:4 with washed gravel ¾ in. and less in diameter. The slabs, about 26 ft. long over all, weigh about 160 tons each, and were cast in place with bearings about 1 ft. 4 in. long on the pier tops, as described in the Engineering Record of Aug. 9, page 144.

Considerations Governing Design

As the water is shallow and there is very little current, and as the present bridges are not over 8 ft. above low water, with bents every 12 ft., the consideration of obstructions to the waterway, either vertically or horizontally, other than the requirements of the United States Government and of the original charter granted by the State of Maryland, did not seriously affect the design, which was governed entirely by the considerations of economy of first cost, durability and economy of maintenance.

On account of the very soft bottom, it was found that the structures would have to be supported on piles varying from 30 to 70 ft. in length. It, therefore, developed that the foundations would be the largest element of cost. Seventy per cent of all the piles used were between 60 and 75 ft. in length.

As the bridges were to have solid floors, the only three types considered were concrete arches, deck-plate girders with concrete floors, and concrete slabs. The arches were eliminated because of the high first cost and the possibility of slight settlement of the foundations, with the consequent damage to the arches. A careful comparison of the remaining two types was then made, using as an element of the cost of the plate-girder type the capitalized cost of maintenance. The concrete slabs were not considered for spans longer than 30 ft. It was found that as the length of span increased the cost per foot of bridge increased, due to the necessity of increasing the lateral dimensions of the piers and foundations in order to distribute properly the load on the piles. As the piles were figured to carry but 14 tons, a small increase in the length of span added materially to the cost of the pier foundations.

The results of the comparison showed conclusively that the most economical bridge was of the short-span concrete-slab type, and that the economical span of this type was 26 ft. center to center of piers. While the first cost and the inexpensive maintenance were important factors in the determination to adopt this type of bridge for this location, the fact that slight settlements of the piers would do little or no damage to the structures was of equal importance.

Slab Design

The slabs were designed as independent rectangular beams, expansion joints being provided at every third pier, and no attempt being made to provide continuity over the other piers. The live load used was in accordance with the Pennsylvania Railroad specification of 1912, which, for a span of this length, consists of one 191-ton locomotive, exclusive of tender, having three driver-axle loads of 70,000 lb. each, spaced 7 ft. apart, on each track. The allowance for impact was in accordance with the Pennsylvania Railroad formula, and in this case amounted to 48 per cent of the live load.

The live load on each track was assumed to be distributed transversely by means of the 100-lb. rails, the 7 x 10-in. x 8-ft. 6-in. ties, the 10 in. of broken stone ballast, and the concrete itself, over 13 ft. of slab. With the above loadings and assumptions the maximum bending moment per foot in width of slab is 1,656,000 in.-lb., and the maximum vertical shear per foot in width of slab is 24,850 lb.

The bending stresses in the slabs were computed by the straight-line formula, the ratio of the moduli of steel and concrete being assumed as 15. It having been determined that the economical slab for the different spans in use by the Pennsylvania Railroad has 25 per cent of the flange steel in the compression flange and 75 per cent in the tension flange, the slabs for these bridges were designed in that way. The allowable unit stress in the steel was 12,000 lb. per square inch for both compression and tension, and the allowable unit stress in the concrete in compression was 600 lb. per square inch. The tension in concrete was, of course, neglected.

The stirrups were not proportioned to take any stress, and were used merely to insure accurate spacing of the main members and to support the top rods and bent-up rods while the concrete was being poured. The shear or diagonal tension at the ends of the spans was resisted by having all of the tension rods bent up, as shown in the plans. The maximum vertical shear in the concrete at the end of the slabs amounted to only 60 lb. per square inch.

All of the main reinforcing rods are 1¼-in. square twisted steel, being twisted one complete turn in a length of 15 in. All of the compression rods are straight and horizontal, and are located a minimum of 3 in. from the top of the slab. All of the tension rods are accurately bent up at the ends in the form of parabolas. These rods are bent up at points approximately one-twelfth, one-seventh and one-fourth of the span from each end, and the number of rods in each set is approximately in the proportion 3:2:1 respectively. The parabolas which the bent portions of the rods follow are so laid off that all bent rods will be approximately normal to the probable line of maximum diagonal tension at the points where they cross this line.

The bending of the rods to the parabolic form was found to be a very simple matter. If the rod is secured at the point of tangency, and the free end bent around a few pins by taking hold of the end of the rod, the natural bend was found to correspond almost exactly with the parabolic line.

The lower portions of the slabs were reinforced at each end, beyond the points of tangency of the bent-up rods, with short horizontal rods extending from the ends of the slabs to a short distance beyond the point of tangency. All rods were securely wired at all intersections with the stirrups, with transverse horizontal rods spaced approximately 2½ ft. apart in both top and bottom of the slabs and extending the full width of the slabs.

The bridges were designed under the direction of Mr. H. R. Leonard, engineer of bridges and buildings of the Pennsylvania Railroad Company, and were built by Henry Steers, Inc., and the Brann & Stuart Company, Inc.

Railway Earnings and Operating Expenses for Four Years

Statistics as to operating revenues and expenses on the railways of the United States for each of the last four fiscal years (ended June 30) are given as follows in a leaflet issued by the Bureau of Railway News and Statistics:

	1909-10	1910-11	1911-12	1912-13
Average miles operated	239,052	244,476	246,511	248,817
Operating revenues	$2,787,266,000	$2,789,761,669	$2,873,279,985	$3,171,445,992
Operating expenses	1,847,189,000	1,915,054,005	1,990,061,981	2,200,991,281
Ratio to revenue	66.27	68.64	69.26	69.40
Net operating revenue	$940,076,000	$874,707,664	$883,218,004	$970,454,711
Net revenue from outside operations	2,684,000	1,815,193	1,243,319	1,576,103
Taxes	104,144,000	108,219,512	121,797,743	129,581,478
Net operating income	838,617,000	768,303,345	762,663,579	842,409,336
Same per mile of line	3,508	3,143	3,094	3,384

The figures show a higher operating ratio than for any year since 1907-08, when it was 69.67 per cent. This high mark was caused, according to the bureau, by the inability of the railroad companies "to meet the collapse of $300,000,000 in earnings with corresponding curtailment of expenses. Through drastic economies this ratio was reduced to 66.12 per cent in 1909, from which increases in wages and in cost of materials have gradually forced it to a point where the largest traffic on record has not sufficed to keep it within the margin of safety."

This operating ratio is normally about 3 per cent below the yearly figure for the first half of the fiscal year—September and October being about the most favorable months for economical operation—and 3 per cent above for the second half. This year the disastrous floods forced the April ratio up to 75.50 per cent, which brought the average for the half year up to the unprecedented figure of 73.40 per cent.

Gasoline Railway Speeders are used by the Forest Service for forest fire-protection purposes. They follow trains on steep grades where sparks thrown out by forced draft are likely to cause the starting of fires along the right-of-way.

Resolutions of the Road Congress

Adopted at Detroit, October 3, 1913

Whereas the loss by reason of bad roads which everywhere lessens the profits of industry, increases the cost of living, and burdens business enterprises amounts to millions annually; therefore, be it

Resolved, That the American Road Congress earnestly favors the creation of a National Department of Public Works directed by a secretary, who should be a member of the President's Cabinet.

Resolved, That the American Road Congress favors State highway commissions and State aid for the construction and maintenance of the main roads of the several States.

Resolved, That the American Road Congress favors the establishment of a national road system, and the construction by the States, counties and towns of the lateral and connecting market highways.

Resolved, That the American Road Congress respectfully requests the Congress of the United States to authorize the President to appoint a commission from civil life, and make sufficient appropriation to enable it to make a thorough and exhaustive report on and recommend a system of Federal aid.

Resolved, That the American Road Congress respectfully petitions the Congress of the United States to adopt the necessary legislation, so that the United States may hereafter be officially represented at the International Road Congresses.

Resolved, That the American Road Congress favors the investigation by the United States Office of Public Roads of applications for patents affecting road and bridge construction before letters patent are issued.

Resolved, That the American Road Congress commends the Lincoln Highway Association for its efforts in seeking the establishment by popular subscription of a transcontinental highway as an enduring and useful memorial to Abraham Lincoln, and further commends the National Old Trails Association for its splendid work in rebuilding the Cumberland Road and the Santa Fé Trail.

Resolved, That the American Road Congress emphatically endorses the compulsory use of wide tires and the road drag.

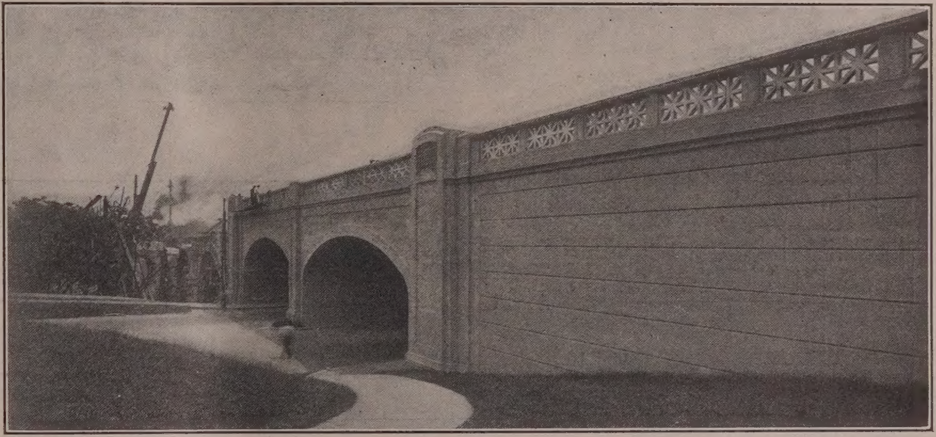
Resolved, That the American Road Congress favors, wherever practicable, the use of convicts in road construction and maintenance.

Resolved, That the American Road Congress favors long tenure in office of experienced and efficient highway officials.

Artistic Masks for Ugly Bridges

Pennsylvania Railroad Has Incased Unsightly Eight-Track and Five-Track Plate-Girder Spans in Ornamental Concrete

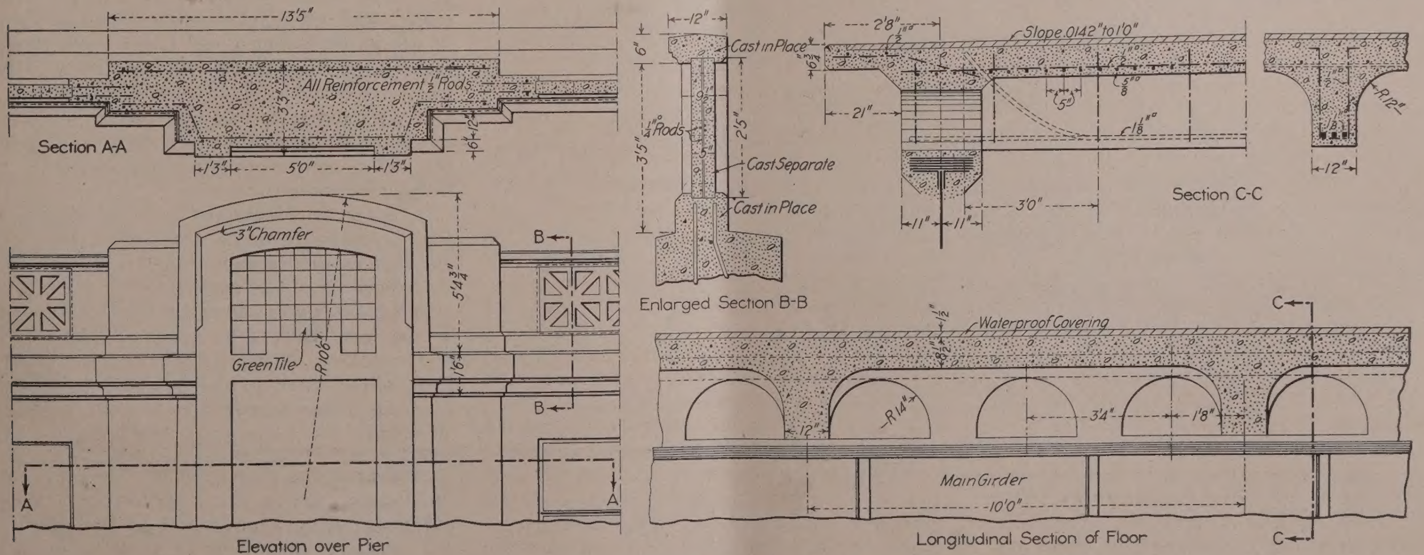
The eight-track, two-span through bridge carrying the tracks of the Pennsylvania Railroad Company over Broad Street, North Philadelphia, is about 143 ft. long on the skew and 170 ft. wide parallel to the axis of the street. The heavy plate-girder construction, low clearance above the street and the lack of curves or graceful lines in the framework make for the disagreeable appearance so often observed in railroad viaducts. Skill and study in the treatment of an inclosing mask of concrete that primarily serves to protect the steelwork, together with an artistic design for the parapet, abutments and wing walls, have transformed a forbidding-looking structure to a pleasing one, which is ornamental in general effect, without materially increasing the expense or detracting from the efficiency of the bridge.


Ornamental Pilasters and Reinforced-Concrete Handrail for Park Bridge

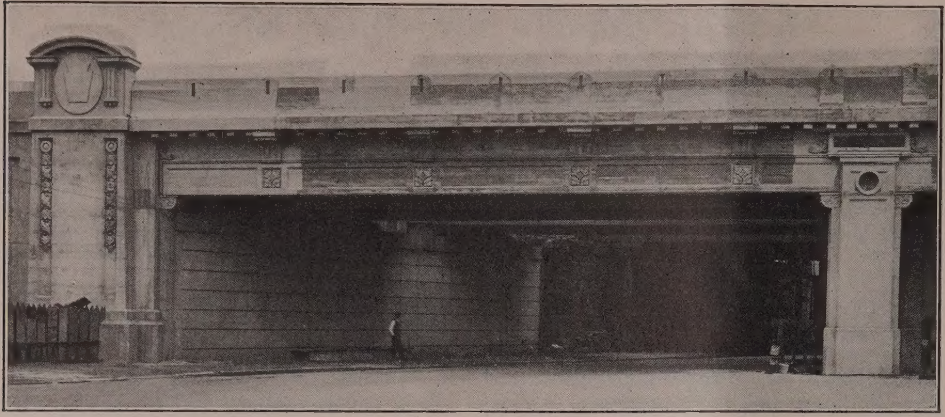
The construction consists essentially of eleven lines of main longitudinal girders supported at the end of the bridge on the abutment walls and at the center on vertical columns. These girders carry eight tracks on 18-in. 55-lb. transverse I-beams, spaced 21 in. apart, and connected by hitch angles to the girder webs about midway between the top and bottom flanges. The center group of four tracks is flanked on each side by a passenger platform with a reinforced-concrete floor slab carried on transverse reinforced-concrete beams seated on the top flanges of the girders. The tracks are laid in stone ballast supported on a paved concrete floor, which forms a solid mass, inclosing the transverse I-beams and thus protecting them completely from the weather. The floor concrete is carried continuously around the webs and flanges of the longitudinal girders, to which it is anchored by longitudinal rods.

The outside girders have riveted brackets projecting from the top flanges to support a heavy molded solid concrete cornice and parapet wall above. The columns are inclosed in pairs in solid masses of concrete, with panels and molded spaces harmonizing with the finish on the exterior of the fascia girder. The wing walls and the abutments have corresponding moldings and panels, giving them a pilaster effect, with extensions above the top of the parapet which define the limits of the spans and diversify the principal structural lines.

The panels, both in the pilasters and in the fascia girders, have a slightly ornate treatment corresponding to stone carving of conventional design, as shown in the accompanying photographs. The ornamental portions were cast in sections in special molds, which produced very smooth finished surfaces and



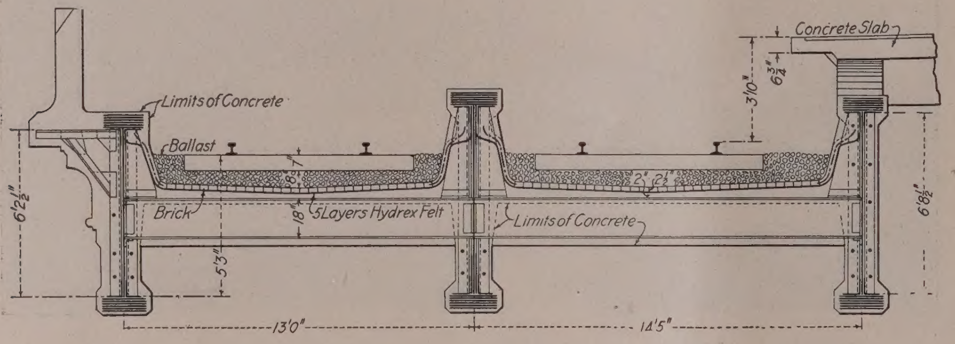
Details of Pilaster, Moldings of Spandrel Wall, Floor Construction and Parapet



Ornamental Fascia for Plate-Girder Span over Broad Street

sharp lines and were provided with steel dowels built into the monolithic mass into which the faces are securely cemented.

Another bridge of similar design and treatment is that carrying five tracks of the railroad over Girard Avenue between the Zoological Gardens in Fairmount Park and the Schuylkill River. It forms part of the approach to the new Schuylkill River concrete arch bridge. Here the improvement required a revision of the old overhead crossing, which was replaced by spans giving a wider roadway clearance. These spans are supported by the abutments and three rows of steel columns, making an acute angle with the bridge axis. There are six lines of plate girders with spans of about 33 ft. and 34 ft. over the sidewalks and 68 ft. over the driveway, which has a center line of columns. All of the steelwork is inclosed in protecting concrete, which, on the outside of the fascia girders, is molded and paneled in harmony with the pilaster effect made by carrying up the column facing to the tops of the girders. Wider pilasters are formed on the ends of the abutments, giving a tower-like effect, and are decorated in their upper panels at parapet level by an inlay of green tiles.

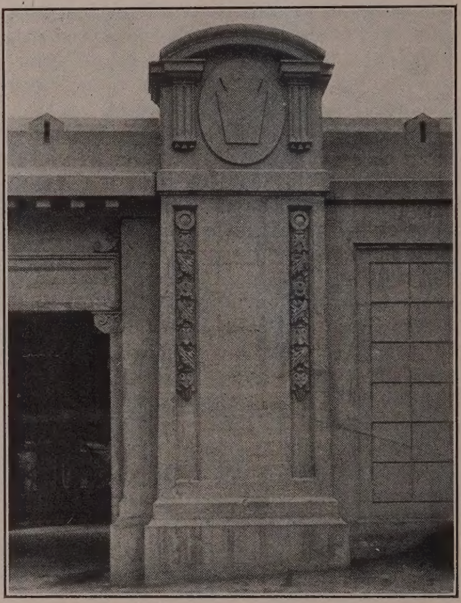


Part Sectional Elevation of Tracks and Platform and Concrete Protection

The parapet or handrail surmounting the fascia girders between the column pilasters consists of heavy open-work concrete in panels 6 ft. 7 in. long, separated by plain panels 1 ft. 4½ in. long. The effect is very harmonious and attractive and the handrail, although much more expensive than plain construction, is considered satisfactory.

The open-work panels of the handrail are cast separately in steel molds. They are rectangular perforated slabs 5 in. thick, reinforced with ¼ in. vertical, horizontal, and diagonal rods. They are cemented in 5 x 1-in. slots formed in the top of the fascia concrete and have solid, cast-in-place, reinforced-concrete caps correspondingly slotted to receive them.

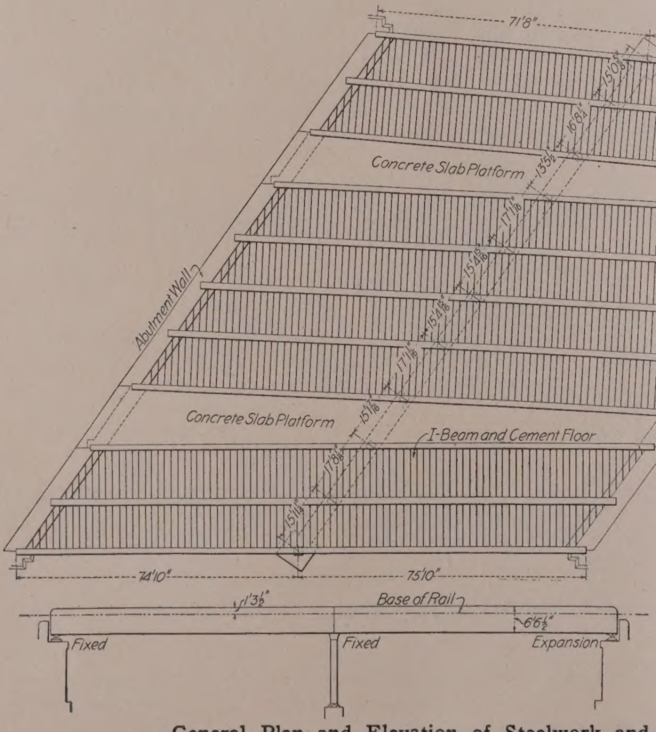
The effect of the handrail is shown in the view of the adjacent bridge over the Lansdowne Drive in Fairmount Park. This five-track bridge has two five-centered reinforced-concrete arch spans, with the spandrel walls, piers and abutments paneled to relieve the dressed concrete surface. The upper part of the abutment panels is decorated with green tiles 6 in. square set in the face of the concrete. The abutment pilasters define the limit of the bridge and their larger dimensions make them more impressive than the center-pier pilaster, which is treated in similar manner, except that it has no ornamental panel at the top, an omission which impairs the general effect by creating an impression of a deficiency of central motive.



Pre-Molded Ornaments in Mass Concrete

In order to secure the greatest clearance for the vehicular traffic under the bridge the intrados at the springing line is curved too sharply for the best appearance.

The bridges were designed and constructed by the Pennsylvania Railroad, of which Mr. A. C. Shand is chief engineer and Mr. H. R. Leonard engineer of bridges and buildings. Plans were also approved by Mr. M. L. Cook, director of the Department of Public Works, and by Mr. G. S. Webster, chief engineer, Bureau of Surveys of the city of Philadelphia. The ornamental features were designed in conformity with the suggestions of the City Art Commission, of which Prof. Paul T. Cret of the University of Pennsylvania is president.

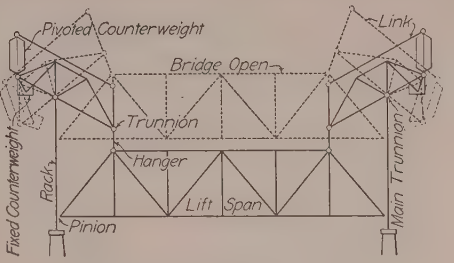


General Plan and Elevation of Steelwork and Platforms

Direct-Lift Bridges

Spans Lifted Vertically by Pivoted, Rigidly Connected Counterweight Trusses

Cables have heretofore been in general use for all vertical-lift bridges, and such cables have been the only means employed where the height of lift exceeded that required for low craft. The use of such cables in the operation of vertical-lift bridges is eliminated and simple construction and operation are secured by the operation of movable spans with direct-connected and counterweighted trussed levers. A number of different designs for structures of this class have been developed by the Strauss Bascule Bridge Company, of Chicago, and are illustrated in a recent circular which explains the operation, demonstrates the exact balancing of the moving span in different positions, shows the application of the principle to different practical and ornamental considerations and gives elevations of several structures now under construction.



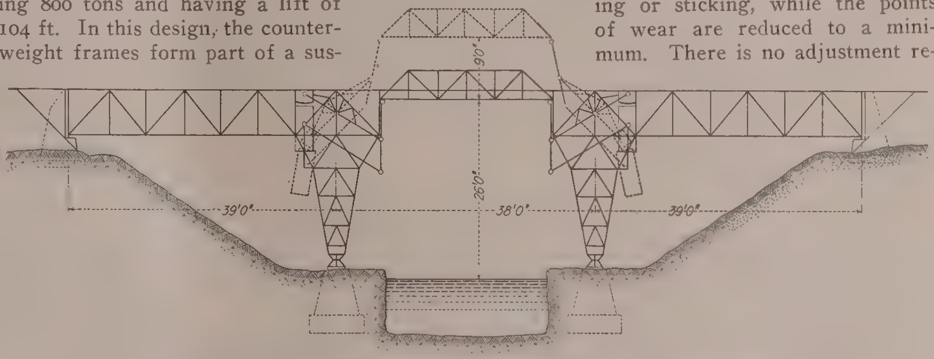
General Type of Direct-Lift Span

Design and Operation

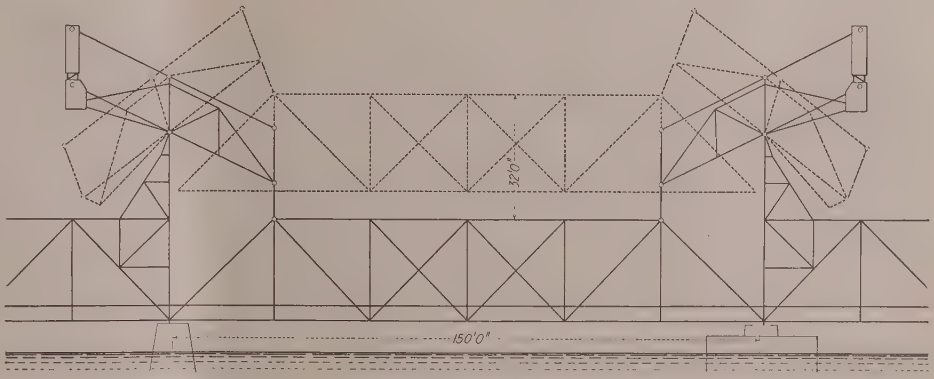
The essentials of the Strauss direct-lift spans are stiff-chord trusses pivoted near the ends to the usual counterweighted paralleling mechanism of the Strauss bascule bridges, mounted on braced tower posts between which the span moves vertically. The lifting trusses are mounted on main trunnions connecting them to the towers and at their extremities have pins which receive the loads of the movable span and of the counterweights only. The main counterweights are pivoted, and are so controlled by links that their centers of gravity move in vertical lines, thus exerting constant moments and maintaining exact balance with the span. Auxiliary fixed counterweights are attached to the lifting trusses to establish their centers of gravity on their trunnions and eliminate all unbalanced moments, thus promoting safety in operation.

Usually the operating mechanism comprises pinions on the lift spans engaging fixed vertical racks on each of the tower posts, operated by motors, gearing and shafts installed on the lift span and controlled, with the end locks, from the operator's cabin there. The lifting trusses are connected with the moving span by rigid links pivoted to the span at the second panel points from the ends, thus reducing the stresses in the opening span, and facilitating its erection in suspended position by the cantilever method without the use of falsework.

In this design the principle involved is an entirely new one, which has been recognized by the issuance of a general patent covering the moving of a span vertically by means of a plurality of levers at each end connected to it and its supports. The striking feature of the system is the ability to secure a height of lift as great as 150 ft., which, as already stated, has only been attained heretofore by the use of cables, so that the invention represents a distinct advance in the art of movable-bridge construction. The flexibility of the system is such that it has resulted in quite a series of types, which embrace a short plate-girder span operated by beam levers instead of trusses; a span with 240-ft. arch-like trusses pivoted near the quarter points; a span lifted from a single tower at the end, shown applied to a double-deck structure of 200-ft. span; and a combination suspension and lift bridge shown applied to a 295-ft. span weighing 800 tons and having a lift of 104 ft. In this design, the counterweight frames form part of a suspension chain truss adapted to ornamental treatment, and this has been made the basis of a monumental design proposed for a number of boulevard crossings of the Chicago River. A further adaptation of the principle is a design with counterweights located underneath the span. By the use of this modification of the system all lifting apparatus above the floor is eliminated.

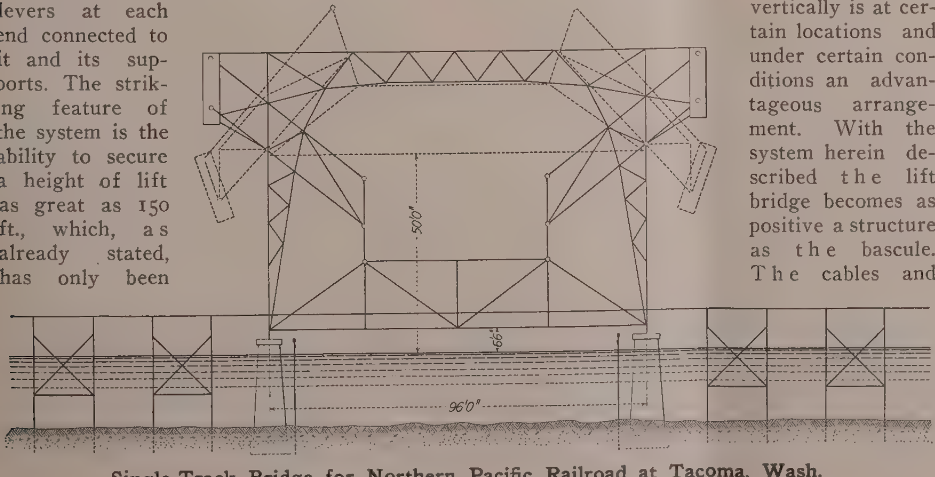


Counterweight Type of Direct-Lift Bridge without Counterweight Pits



Chicago, Burlington & Quincy Single-Track Span at La Salle, Ill.

A bridge lifting vertically is at certain locations and under certain conditions an advantageous arrangement. With the system herein described the lift bridge becomes as positive a structure as the bascule. The cables and chains usually required are replaced by rigid structural-steel members and simple pins so that the action becomes equivalent to that of a trunnion bascule bridge in which there is an accurate balance and an absence of binding or sticking, while the points of wear are reduced to a minimum. There is no adjustment required with this design after construction, and as already mentioned, there are no unbalanced movements which would effect the safety of operation.



Single-Track Bridge for Northern Pacific Railroad at Tacoma, Wash.

English Road-Testing Machine

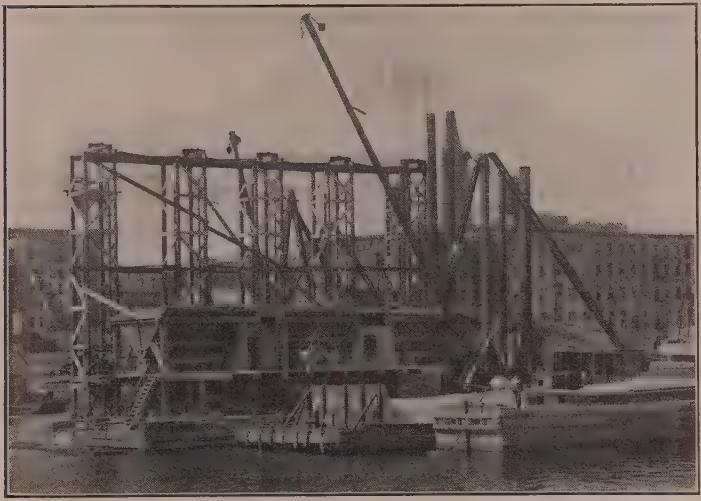
A road-testing machine has recently been installed in the National Physical Laboratory at Teddington, England, according to "Good Roads." A circular track 104 ft. long furnished the base for the various types of roads. A horizontal frame, consisting of spokes connecting to eight wheels resting upon the test road surface, completes the apparatus. Each wheel is 3 ft. in diameter and may be fitted with tires of every type known to traffic. The weight carried by a wheel can be varied, as can the speed and the inclination of the wheel to the surface. Other devices for approximating the conditions imposed by climate or weather are provided, and sprinkling of the road surface forms a part of the test.

Although but few tests have so far been completed, several definite facts seem to be indicated. Col. R. E. Crompton, consulting engineer of the road board, states that apparently road repairs are necessitated not by surface wear directly but by the displacement of the stones in the body of the road.

Concreting the Harlem River Subway Tunnel

Inclosing the Submerged Four-Track Tubes with Concrete Deposited by Tremies

The four tracks of the Lexington Avenue subway cross the Harlem River, in New York City, about 60 ft. below water level in a steel and concrete tunnel, which forms part of contract section No. 14. The tunnel section, 1080 ft. long, 76 ft. wide and 24½ ft. high, consists of four steel tubes 19 ft. in diameter, with a clearance of 2 ft. between their flattened vertical sides. They are connected by vertical transverse diaphragms about 15 ft. apart, which project 3 ft. beyond the tubes and have their vertical edges connected by continuous lines of wooden sheeting. The steelwork is built on shore in sections about 220 ft. long, floated to position, and sunk in a dredged trench, as described in the Engineering Record of Sept. 13, page 284, and Oct. 4, pages 372 and 390. After sinking, the pockets between the transverse diaphragms and the longitudinal sheeting are filled with concrete deposited under water to form a continuous footing, which supports the tubes on the bottom of the trench and entirely incloses them with a solid mass of masonry to protect them and add strength and stability. There will be required for this work about 45,000 cu. yd. of concrete, which is now being placed by a floating plant especially designed and constructed for this purpose.



Delivering Aggregate to Storage Hoppers on Concrete Boat

Tremies on Concrete Boat to Fill Submerged Pockets

Floating Concrete Plant

The concrete plant is installed on a 35 x 110 ft. wooden scow, equipped with two steam boilers aggregating 90 hp, which operate the hoisting and mixing machinery and an Ingersoll-Rand air compressor with a capacity of 800 cu. ft. per minute, which, although not required for direct concrete purposes, is ready for use in case of necessity to control the sinking of the successive sections of steel tubes. On one long side of the scow there are five 6 x 6 ft. braced wooden towers 50 ft. high, placed so that when the intermediate ones are centered over the clearances between the tubes the two outer ones will be centered over the clearances between the exterior tubes and the wooden sheeting, thus allowing a tremie tube from each tower to pass through the clearances to the bottom of the trench in which the tunnel is constructed.

In the rear of the towers there are installed on the deck of the scow three 1-yd. Lakewood concrete mixers, which are supplied by gravity with sand and gravel from three hopper-bottom 8-yd. double bins behind them. The sand and gravel are delivered on 500-yd. deck scows, each carrying sand at one end and gravel at the other, and are unloaded by a 1½-yd. clamshell bucket operated by the 80-ft. boom of a stiffleg derrick installed on the concrete scow.

In each tower there is a rectangular 1-yd. steel bucket which receives the concrete direct from the mixing machine and is hoisted by a separate engine attached to the tower. On the outer face of each tower there is a vertically movable 12-in. tremie tube 60 ft. long, terminating at the upper end with a long and narrow hopper of 1½-yd. capacity. A light railed working platform is attached to the hopper, and with it the tremie tube is suspended by a rope passing over a sheave on the top of the tower, and can be raised or lowered about 40 ft. by the operator, who commands the tackle of the hoisting engine through an endless rope close to the working platform, which passes over the top of the tower and is attached to the throttle lever.

Concreting

The concrete scow, moored at both ends by lines to anchor piles, is placed above the submerged tubes, with its axis transverse to them, and is adjusted so that the tremies, being lowered until all of them enter the same 15 x 76-ft. pocket, swing freely on each side of each tube, with their lower ends on the bottom of the trench. The tubes and hoppers being all filled with concrete, the latter flows from the open lower ends of the tremies, and being mixed very wet escapes under pressure and flows horizontally with a very flat slope, reaching from tremie to tremie under the tubes and covering the entire bottom of the trench.

When sufficient concrete has escaped to block the bottom of the tube the remainder maintains a constant height in the tremie up to a maximum at the top of the tremie hopper. The concrete is not allowed to remain in the tremie tube more than five minutes, and all of the tubes are operated simultaneously. If a tremie hopper is still full of concrete when the supply bucket commences to ascend the tower, the operator immediately pulls the throttle rope and operates the hoisting engine to raise the tremie tube, hopper, and working platform and to allow the concrete to escape fast enough to provide room for receiving the next batch, which is automatically dumped into the hopper.

The tremie tubes are watched with great care and are handled with rapidity, pains being taken to always retain enough concrete in them to form a water seal. The seal can be seen by looking down from the top, and it effectually closes the bottom and prevents any inflow of water. The concrete is made 1:3:6 with Dragon Portland cement and 1-in. well-graded gravel, and flows so readily that no difficulty is experienced in making it spread over the bottom of the trench and fill all spaces around the tubes, a result which is verified by a diver who watches the work, but never has occasion to disturb the concrete.

Each of the thirteen pockets in the tunnel section now being concreted contains about 475 cu. yd. of concrete, which is placed in one eight-hour shift by a total force of 35 men, including two relay divers. The concrete is filled flush to the tops of the pockets and the scow is gradually pulled forward and back by its mooring lines to traverse the tremies from end to end of the pockets as the work progresses. Each day a scow is advanced from one pocket to another. Ordinarily the tops of the tremies are maintained at approximately the same level, but any one of them may be raised or lowered as required without interfering with the others.

Although the high towers on one side of the scow give it a top-heavy appearance, it is very steady, and the heavy machinery installed on the deck and the material bins near it give it sufficient stability. All of the space on it is well occupied, since its dimensions were somewhat restricted by the necessity of making it small enough to have clearance in the slips on both sides of the river and to clear the electric conduit pier of the New York Central & Hudson River Railroad which interferes with the tunnel at one end.

Work is being executed under the direction of the Public Service Commission, of which Mr. Alfred Craven is chief engineer, Mr. Robert Ridgway engineer of subway construction, and Mr. C. V. V. Powers division engineer. The Arthur McMullen & Hoff Company is the contractor, for whom Mr. N. R. Melvin is superintendent in charge.

A New Map of Niagara Falls is included in the Niagara folio prepared by the U. S. Geological Survey. The falls and gorge have been accurately mapped on a large scale. An illustrated description of the origin and history of these geologic formations accompanies the map.

AMERICAN ROAD CONGRESS

Abstracts of Some of the Papers Presented at the Third Annual Convention in Detroit, September 29 to October 4

Lessons from the International Road Congress

By Col. William D. Sohier, Chairman Massachusetts Highway Commission

I am sure I am speaking for the American delegates when I say that I feel it was a shame that the United States was not officially represented at the International Road Congress held in London last June. All the European countries and England not only belong to the International Association but were represented by large numbers of their leading engineers—men who would rank with any of our engineers in this country. It would seem to them as if the United States was not a nation but merely an aggregation of States. I personally represented the State of Massachusetts, and many of the other delegates represented other States. The State of Massachusetts joined the congress as a State; and out of courtesy, not as of right, our delegates were recognized. It should be a right and not a courtesy.

By having Massachusetts, New York and other States represented in this way, by courtesy of the convention, merely put us on the same footing as Siam or Borneo. It was very mortifying, and I believe very poor policy for this country. I hope that all members of this congress, representing all the States in the States in the Union, will join with me in my endeavor to see to it that this is rectified before the next International Road Congress.

The resolutions adopted by this and the former International Road Congresses are conservative, because they have to represent the diverse views of various countries where conditions and road systems are totally different, and should, therefore, be carefully studied and followed almost everywhere. In some places it would be well to go further in the same direction. (The resolutions were published in full in the Current News Section of the Engineering Record of July 19.)

New Streets and Roads

On general principles it was decided that new main roads on through routes should be constructed by passing outside rather than through the small villages. This would make the road safer and would be much less expensive than a wholesale tearing down of buildings, which would be necessary to get sufficient width.

Grades should be as easy as possible, especially where there was much heavy traffic. Curves where there was fast traffic should provide the best posible view and the longest possible radius. When a short radius was inevitable there should be marks showing the danger.

Street railway tracks, if they could not be placed in a specially reserved space, should be in the center of the road, and space should be provided on either side for two tracks for vehicles. In laying out new main traffic roads sufficient space should be allowed for what may ultimately be required, like street railway tracks, room for fast and slow traffic, etc.

The planning for these main roads of communication should be undertaken at once, and it was important that central State authorities should take interest in the matter and be given, to some extent, the supervision and authority.

The resolutions recognize the fact that high-speed light motor vehicles rapidly destroy waterbound macadam roads but do not cause serious or exceptional wear or damage where the roads had been properly treated with some bituminous material, except on curves; also, that it was most important with heavy traffic that the width of the tires, the diameter of the wheels and loads to be carried should be regulated.

A resolution was passed relating to the regulation of fast and slow traffic to the effect that some authority should be established to regulate and direct this traffic at all congested points and that the regulation should define the rights, duties and responsibilities of each kind of traffic, including not ony vehicular but pedestrian traffic.

A resolution was adopted that the unit of highway administration must always be sufficiently large and should command sufficient money so that a competent staff of engineers could be employed. This question is of great importance in this country; in fact, of more importance, it seems to me, than any other, because I believe that in many places the public money spent on roads is largely wasted from the lack of proper engineering advice and adequate supervision.

Money for New Roads

I would call special attention to one particular resolution, as it seems to me most important at this time in this country, where so many States are borrowing money, and even the National Government has considered entering into the work of road improvement. This resolution is to the effect that borrowing money for new main-road construction is only consistent with sound financial principles, provided the loan period, in the case of loans for renewals, is kept well within the life of the surface coatings, and, of course, also well within the life of the road, or that enough of it is paid during that period to cover the deterioration of the road surface.

We must not expect too much in this country, where we have approximately 2,000,000 miles of public roads. We must recognize the money which will be required and the time which must elapse before we can even think of attaining the position that France or England now holds in regard to roads. Their roads have been built for years, and to a large extent are of macadam. Their whole problem is one of maintenance. In France practically all roads are laid out on a uniform width and are of almost uniform construction of some form of macadam. All roadwork is done under the supervision of the Government engineers. Their total road mileage is 371,700 miles, and it cost $1,663,000,000 to build. We must remember that their roads were built years ago, when land was cheap and when labor was much cheaper than now, and that their labor cost to-day is not more than half the labor cost in most parts of this country.

Even with their low cost of labor their national roads cost something over $12,000 a mile; departmental roads, $7,700 a mile; county roads, $6,200 a mile, and their local roads, about $2,500 a mile, or an average cost of nearly $4,500 a mile. But most important of all is the fact that the annual maintenance of these roads is nearly $45,500,000 a year, of which $6,500,000 is provided by the national Government and $39,000,000 by the eighty-six departments. The amount furnished by the departments is practically $1 per year for each inhabitant—man, woman and child.

To secure any such road system in Massachusetts, with her 23,000 miles of road, means years of work and millions of dollars in money; in fact, more than $100,000,000. At the smallest calculation she would have to spend $5,000,000 a year for the next twenty years to build her trunk lines and secondary roads alone.

Roads in France

The most important lesson that France teaches us, it seems to me, is that we should secure proper locations for our highways and sufficient width for all future use. Main French highways are 60 feet in width.

The macadam on the national routes is 24 ft. in width; on the departmental roads, 18 ft.; and on most of the other roads, about 15 ft. There is a grass shoulder on each side, about 15 ft. in width.

Most important is that they are spending more than $45,000,000 a year for maintenance on 371,000 miles of road. This is about $125 a mile a year; and we must remember that all of their roads have been built for years and are practically to-day all waterbound macadam roads, where they have not already put in some more permanent form of construction. Their Minister of Public Works is now recommending that $50,000,000 additional be provided to be used during the next ten or twelve years for some bituminous binder on 6,000 miles of the national roads, where it is greatly needed. France has undoubtedly the best road system in the world so far as location, layout, foundation, drainage, etc. are concerned; but where there is much motor vehicle travel—and that is near the cities—their macadam roads are going to pieces just as fast, I think, as our waterbound macadam roads have been since the advent of the motor vehicles. Wherever the motor traffic is heavy I found the macadam roads extremely rough and going into potholes as they are here; but it is only fair to say that this observation would not cover many miles of road in all out of their 371,000 miles, because, especially near Paris, they are already using tar or some bituminous binder, either in construction or as a surface coat.

One noticeable thing in both England and France was that except near the cities one did not meet even 10 per cent of the number of motor vehicles that one usually encounters here, at any rate in the Eastern States. This accounts for the good condition in which their waterbound macadam roads have remained.

In France, as we all know, they have a patrol system. You still see the piles of stone on the roadside ready to be broken up and put on the road; but in the entire 1,000 miles which I went over, on perhaps only four places—less than ¼ mile each—did I see any dry stone put on the road to fill the holes, and in those instances it was being scattered over the road by the motor vehicles as it is in this country.

They have found it necessary there to use some binder in their patches, and in both France and England I found that they were using tar on their main roads, painting the bottom and painting the stone, and covering with sand, or filling in with stone that was already coated. It was evident to me that in neither France nor England can they maintain waterbound macadam roads where they have more than fifty automobiles a day and still keep them in reasonably good condition without the use of some bituminous material.

Drainage Ditches

Every road that I saw in France had a ditch on each side to carry the drainage. This ditch was usually placed beyond the 15-ft. grass shoulder, and had waterways connecting it.

On almost all of the main roads where there was a grade of 3 per cent or more they had a shoulder on the side of the macadam and a paved gutter about 4 ft. in width. This was made of larger blocks of stone than ordinary paving stone.

One very noticeable thing, and one that we could well copy, was that the gutter was laid out on almost the same crown as the road, so one could travel on it without any inconvenience.

The crown of the roads there was flatter than ours, not more than ½ in. to the foot, often less. I saw many places in the villages and in the parks near Paris where the gutters were across the road. These gutters were constructed so wide and so shallow that at any reasonable rate of speed (say 15 miles an hour) an automobile could go over them without having anyone inconvenienced, even in the back seat.

English Roads

In England they have a different road system than that of France. The county boards and county engineers have charge of the main roads outside of villages, though the Government is now helping to improve main roads, and has a competent board of engineers to advise on the kind of improvement to be made.

The central Government has about $5,000,000 a year with which it is helping its counties to make improvements. This, by the way, is secured from a tax of 6 cents a gallon on gasoline, and from the motor vehicle fees, which are extremely large; for instance, in England a 40-hp Packard would be taxed about $110 a year.

I should judge that England had on its main roads much more motor traffic than there is in France; although even in England, as far as I went, there was much less motor traffic out in the country than there is in this country, though there is a tremendous motor travel near the cities, particularly in London.

What is particularly noticeable in connection with the English traffic is the tremendous number of traction engines and trailers which one meets everywhere hauling from 8 to 10 tons on iron tires. I understand from their engineers that this kind of traffic will rapidly cut through and destroy any macadam road which is less than 5 in. in depth. So far as I could learn, they are now building most of their heavily traveled main roads of at least 9 in. of macadam, the top 3 in. of which is made of bituminous macadam or a tarred slag.

In and around London they have a very large number of motor buses, which travel on rubber tires and often go 10 to 25 miles out in the country, with a five-minute service. They are practically like our 6-ton trucks.

The road surfaces there are remarkably good, and they have now about 40,000 miles of road where the surface has been coated with tar. On the whole, I should say that their road surfaces on main roads were much better than those in France, because they have used so much more tar and bituminous macadam. In England and in France they are covering all their tarred surfaces with sand, gravel, or pea stone and dust.

On the other hand, the English layouts are inconceivably bad. Their roads, even on the main lines of travel, are extremely narrow, and the corners very blind. Often there is not room to pass the traction engine that one so frequently meets. I measured several roads where the distance between banks on the road was only 9 to 11 feet.

The surfaces, however, were almost uniformly good, except near the cities, where the motor travel was heavy; and here again the waterbound macadam road was full of holes and rapidly going to pieces when it had not been treated with tar. It is only fair to say, however, that most of them were treated with tar. Right near Hyde Park in London I saw as rough a piece of macadam road as one could find anywhere in this country near any of our cities.

As in France, the whole width of road surface was made suitable for travel from shoulder to shoulder. The drainage was poor. Many times it looked as if the road was going to carry the water from the surrounding country, and would be something more like a drainage canal than a road in a heavy downpour. They have, however, realized the importance of the drainage problem and are rapidly making great improvements.

Maintenance

We can learn a great deal from the English in the matter of maintenance. With a total of more than 150,000 miles of road in England and Wales, they classify as main roads 27,800 miles. The average cost of maintenance of these 27,800 miles of road is $475 per mile per year. About 95,000 miles of road in England are maintained by the local authorities; they are called rural roads. Even on these roads the average amount spent for maintenance per mile per year is $115. Remember that their labor costs much less than in this country.

On 2,173 miles of road maintained by the London authorities (not including the London County Council) the average cost of maintenance is $1,675 per mile per year,or that was the cost some years ago; I am informed it has substantially increased. No wonder they can keep good surfaces.

The engineer in the County of Lancaster, Mr. Schofield, told me that he had more than 600 miles of road to maintain, and that this year he had an average of $1,500 a mile for maintenance. Of course "maintenance" means not only ordinary maintenance, but includes resurfacing and even reconstruction. Mr. Schofield told me that many of his roads had an average of from 50 to 75 traction engines, hauling trailers, going over the road every day. He said they had absolutely destroyed the 6-in. waterbound macadam road and that he was reconstructing his roads with what we would call a Telford base and 9 in. of macadam, with the top 3 in. made of bituminous macadam. To build a road of this character in Massachusetts would cost from $20,000 to $25,000 per mile for a road 18 ft. in width.

In the towns in his county that I went through he was building granite block pavement grouted with cement laid on a 6-in. concrete base.

Resurfacing

In England and France I saw many places where resurfacing was going on. They were uniformly resurfacing with what they called a granite, either Belgian or Welch—what we should really call a trap. What impressed me particularly was that if they resurfaced at all they used what we call a No. 1 stone, at least a 2½ or 3-in. stone, and only about 10 per cent of the finer stone. This was true wherever they were resurfacing. In France where I saw them resurfacing they were generally using stone alone, but in England they were putting on slag, coated with tar, of this large size, or a 3-in. stone coated with tar. Their method was to lay this stone "one stone deep," roll it slightly, and then roll in ten per cent of No. 2 and some chips coated with tar. I saw several of these roads, which carried very heavy traffic, that were in very good condition indeed, although three or four years old.

In Liverpool I saw one tar-macadam road built by the "Brodie Method," which is to grout the top 3-in. No. 1 stone when it is rolled with a mixture of equal volume of tar and sand. The sand is heated to the temperature of the tar, the mixture kept agitated and poured evenly into the stone until it flushes to the surface, and then 10 per cent of No. 2, or finer stone, is rolled in. This road was eleven years old, and still in very good order, whereas a waterbound macadam road, just beyond, carrying the same traffic, had been resurfaced three times in the eleven years and to-day is rougher than the tar macadam.

I was informed that they never close the road in England or France for resurfacing. Personally, I must have gone over at least one hundred places where the roads were being resurfaced, and invariably, whether it was waterbound macadam, tarred macadam or tarred slag, they were repairing one-half of the road only, and left one-half, over which one could pass in reasonable comfort. At four or five places where I inquired I found that they did very short stretches at a time, and at night finished up with a square end. At no place in either England or France could I discern any line in the middle of the road where the joining came.

Character of English Tars

There is still another observation I would like to record, and that is that the tars in England seemed very much more lasting, more elastic and more sticky than ours. I saw only 1 mile of road in all where the tar surface seemed to be picking up—in other words, where the stone showed below it; and in that instance it would undoubtedly be patched at once and before a pothole came. With that one exception, their tar surfaces were practically perfect. There were no potholes, and when one dug into the tar it always seemed alive, sticky and soft.

On only a very few miles of road was there any of that mosaic effect that we had been told about. The engineers told me that that effect came the first year when they had used only, say, 1/6 gal. of tar per square yard, and where it had worn off on the tops of the stone; but when they received a second application, with sand covering, it made a blanket coat similar to one we have in this country.

In Massachusetts we find we can maintain our oil and tar surfaces most economically by having a team and three men constantly patching from 6 to 8, or even 10 miles of road. If this work is well done we never have any holes.

Another important consideration was that in both England and France all roadwork is in charge of competent, trained engineers, who not only have technical training but many years of practical experience. They stay in office as long as they are competent and efficient; it is not a matter of politics. They have entire charge of roadbuilding and road repairs, and employ efficient foremen and workmen. These facts largely account for the results obtained.

Another most valuable lesson that our cities could learn from the practice in most of the cities abroad is to leave street surfaces alone after they are built. When this is impossible and the street has to be dug up, the street department relays the pavement or surface and collects the expense of putting the surface into good condition again and maintaining it for a reasonable period of time. Water pipes, local sewers, gas, electric conduits, etc., should be so located that they can be connected with the buildings without disturbing an expensive street pavement. It is no unusual sight in my State to see a street dug up two or three times in one year, and it is hardly ever properly repaired. In consequence, paved streets that would have remained in good condition twenty to forty years have to be reconstructed in five or ten years at enormous cost. In the meantime they are in wretched condition. The time has come, in my opinion, when no one should be allowed to dig up our roads and streets anywhere, no matter how influential the corporation or individual may be, without having to pay to the department in charge of the road enough money to put the street back into its former condition.

CONCLUSION

In conclusion, I would not discourage any "good-road" movement in this country, but we must go at it in a proper and scientific manner and know what our problem is before we tackle it, then proceed in a businesslike manner to build our roads.

We must realize the enormous amounts of money involved, and we must also realize the tremendous amount of money that is required to keep the roads in good condition after they are built.

In my opinion we have engineers who can do as good work in this country as anyone has done abroad.

We may even learn to build them better, but we must realize that it requires education, skill, intelligence and experience, and that constant maintenance is absolutely essential.

Maintenance begins the day the road is built and continues as long as it is used, and the money for maintenance must be provided as well as the money for construction, or we shall find that the bonds issued to construct our roads still remain to be paid when the roads have long passed away.

The money cannot be provided nor the roads built at once. If we are to secure good roads we must all join hands—the town, the city, the county, the State, and possibly the nation also; but it must be upon a carefully prepared plan made by competent engineers after a full study of the whole problem. Only by co-operation can our country secure any comprehensive highway development within the next twenty-five years.

Brick Road Construction

By James M. McCleary, Road Engineer, Cuyahoga County, Ohio

The chief purpose of rolling the sub-base is accomplished when the weak or spouty places in the soil are revealed, so that the engineer can treat them as he sees fit. For this purpose a roller weighing from 8 to 10 tons answers every requirement. Preceding the final preparation of the sub-base the curbs must be placed. In case of most of our rural work curbs are placed flush with the surface of the completed pavement.

With curb set and base prepared the next step is the placing of the concrete base, which with our roads has been 4 in. in depth. In specifying the proportions a mixture of 1:3:5 with a permissible variation according to the size of the aggregates which will most nearly fill the voids meets every necessity.

In laying the brick, first see that the lugs are turned one way. Next make certain that the joints are broken so that one-third or more of the brick of one course overlaps the brick of the next course. Third, be sure that every fourth course is driven up to a straight line. Finally, for the sake of appearance, keep the line of the brick at right angles with the curb.

Care should be taken to see that all soft brick or brick that are burned too hard are removed. Those so heavily kiln-marked that they will cause unevenness in the pavement should be turned. Caution should be exercised in this, for many a kiln marked brick is thrown out which if allowed to remain would have been of more value to the pavement than others that are retained.

USE OF ROLLER

After the brick are thus placed in the street their slight unevenness should be ironed out by the use of a roller not exceeding 5 tons in weight. If a horse roller is used at all, it should have a diameter of at least 5 ft. Rolling should begin on one side and pursue a course parallel to the curb. The roller should return over the same course. This should continue until the center of the pavement has been reached, when the roller should be moved to the opposite curb and rolling repeated.

For grouting joints use a grout filler composed of equal parts of sand and cement. The grout should be mixed in a watertight box with a "lower corner," using not more than 1 cu. ft. of sand and one bag of cement, mixing the mass until it assumes a uniform color. Add water and stir the mixture until it assumes the consistency of thin cream. The mixture should then be applied to the pavement by means of scoop shovels and thoroughly swept into the joints. After sufficient time for setting has elapsed a second coat, slightly thicker, should be applied, and later a third coat, which will assure filled joints. The last coat should be worked either with a specially prepared broom or a rubber squeegee and swept across the joints at an angle of 45 deg.

After the initial set has taken place the pavement should be covered with ½ in. or more of sand and this kept saturated with water for at least five days. The pavement should not be opened to traffic for at least ten days.

To counteract expansion and contraction we have relied mainly on the ability of our structure to prevent moisture from getting underneath the roadway and upon an endeavor to have our cement filler at the greatest possible strength. These provisions, together with a rigid curb, enable us to hold in compression the expansion occurring in our narrow roadways. A few cracks in the pavement have appeared, but have not raveled out so as to injure the traffic worth of the road, and have not been thought of sufficient importance to require repairs.

The facts that our roads are in shape for maximum service twelve months in the year, that they originate no dust, and that washing by rain suffices to keep them clean have so impressed the taxpayers that, although we have buit nearly 400 miles of such road, thirty-three farmers' petitions are now on file in our office asking for thirty-three separate extensions.

Federal Aid in Road Construction

By David F. Houston, Secretary of Agriculture

No one questions that the States and the localities should largely contribute to the support of roads, and I take it, in view of the state of mind of the public, as expressed through its unofficial as well as its official channels, and through concrete legislation, that discussion of the wisdom of Federal encouragement and aid would be merely academic. The main questions for consideration are questions of the extent and character of such aid, and of methods and machinery, Federal, State or local.

The suggestion of great national transcontinental roads appeals to my imagination, as does the suggestion of interstate roads connecting capitals or cities of commercial importance to my logical faculty and to the sense of pleasure that I experience in riding about the country in my friends' automobiles. But that the essential thing to be done is the providing of good roads which shall get products from the community farms to the nearest station and make rural life more profitable, comfortable and pleasurable I entertain no sort of doubt; and it is obvious that the representatives of the people in Congress are like minded. For in making their appropriation they stipulated that it should be used in improving the condition of post roads with a view to the economy and efficiency of postal delivery and for the transportation of farm products to the market. Such roads are equally essential to the establishment and operation of decent elementary and secondary schools for the benefit of the country boys and girls. I do not eliminate other things from consideration and I do not underestimate the rights and pleasures of the automobilists and the service they have rendered in the propaganda for roadbuilding.

APPORTIONMENT OF AID

Who shall say how aid should be apportioned so that the States may receive equitable treatment? Shall it be apportioned equally among the States on the basis of total population, farm population, area, taxable valuation, road mileage, or all these; and should Federal money be expended exclusively through its own agencies for a certain system? What roads are to be improved? There are approximately 2,250,000 miles of publicly owned roads in the nation. Half of this mileage is utilized for post roads and less than ten per cent of the total can be classed as improved in any large sense. Shall we undertake to apply aid to all the roads or shall we consider this a task too gigantic? Shall we apply it to the rural routes or shall we regard this as equally beyond reason? Or shall we single out certain directions in which central roads shall run, and, if so, how? Is it not clear that this opens up a field where petty politics, community interest and individual selfishness may run riot? Assuming that we have settled this, for what purpose shall the aid be granted and in what proportion? Shall it be exclusively for construction, exclusively for maintenance, or for both? Shall it be to pay the entire cost of either or both of these items, or shall it be dependent on the equal or larger contribution by the States and communities? Shall the aid come through votes of money out of the Treasury or from the sale of bonds?

That the suggestion of Federal aid to road-building raises grave questions and involves possible dangers no thoughtful citizen doubts. There are proposals before the public mind which would bankrupt the Federal Treasury and suggest possible abuses before which those of the worst pork-barrel bills of the past would pale into insignificance. No proposal which does not carry with it the assurance of safeguarding the Treasury in this direction seems to me to stand the ghost of a chance of favorable consideration. It is not alone the fear that there would be no stopping place. There is the question of precedent, for this is not the only proposal before the American Congress involving the suggestion of huge appropriations.

It would be especially pernicious if such aid should result in stifling the spirit of local self-help. In this field as in others the States have recently made great headway, and any action taken should unquestionably result in the fostering of this spirit and in the efficient direction of the activities to which it may lead.

Another difficulty to be avoided is the over-centralization of activity in these intimate internal matters and the building up of a great and powerful bureau in Washington, with an ever-increasing control over the highways of the country. The dictates of prudence and experience are that so far as possible such agencies as may be required should be efficiently developed in the several States and that the Federal agencies should work in a spirit of complete and helpful co-operation and assistance.

States as Road Units

The first practical essentials in the planning of road legislation would seem to be to recognize the State as the smallest unit with which the Federal Government might deal. This would give relief in a measure from the insistent demand that would come from every township and every district in the Union for its share of State or Federal assistance, without reference to the merits of the case or the practicability of the undertaking. Many of the States now have efficient State highway departments and thus afford organized agencies with which the Federal office could deal. It would seem that the basic feature would be such co-operation between the States and the Federal Government as would leave with the States the initiative in the selection of roads to receive aid, and as much of the immediate construction and maintenance as would be practicable. In the case of roads on which Federal money is to be expended it would seem essential and wise that the Federal agency should have the requisite power of the approval of the selection, supervison of the construction and maintenance, and the right of inspection, for the plain and simple ordinary purpose of seeing that the Federal money is applied to the purpose for which it was voted and is efficiently expended.

It is reasonably clear that for every reason there must be some automatic check upon the demands to be made upon Congress and that this should be afforded through the requirement that the States and the localities should contribute an amount both for construction and maintenance at least equal to and possibly double that contributed by the Federal Government; and that, in the apportionment of any possible Federal funds, a number of basic factors, such as population, area, wealth, or minimum cost of construction, should control.

In short, as a practical program, I believe that this matter is one in which haste can best be slowly made. The people will sanction a reasonable expenditure of their money—and it is their money, and theirs only, whether it be expended through the Federal Government or the State—when they are convinced that it is applied to a wise purpose and will yield the results anticipated. And I am impressed by the wisdom of the action of Congress, in the midst of so much clamor, in constituting a committee "to make inquiry into the subject of Federal aid in the construction of post roads," in providing an appropriation of $500,000 to be expended co-operatively with the States in the proportion of one to two, and in requiring the Secretary of Agriculture and the Postmaster-General to report to Congress the results of such expenditure, "together with such recommendations as shall seem wise for providing a general plan of national aid for the improvement of postal roads in co-operation with the States and counties, and to bring about as nearly as possible such co-operation among the various States as will insure uniform and equitable interstate highway regulations." This indicates a wholesome desire to know the facts as well as a generous interest. Too short a time has elapsed to judge of the value of this undertaking, but that it is in the right direction few will question. That it might be extended with ample funds if aid is to be furnished most thoughtful men would concede; and the plan has the peculiar value of being susceptible of indefinite extension in case the results should be found to justify it.

Legal Suggestions Respecting Road Contracts

By William Law Bowman, of the New York Bar

Most present-day State contracts for road construction are not really "contracts" because of the inability of the contractor to sue thereon. I have seen one State contract which stated that "all right or rights of any action at law or in equity under or by virtue of this contract and all matter connected with it and relative to the same are hereby expressly waived by the contractor." Practically the same result is accomplished by other States, and especially by municipalities, by the requirement that upon or before final payment the contract must execute a release in full of all claims arising out of or by reason of the work done and material furnished under the contracts. Is this good faith in the dealings of men of average right-mindedness? The remedy is simple. Provide either fair and disinterested boards of arbitration to pass upon a contractor's claims or provide a court of claims and eliminate any waiver of appeal to such arbitrators or court and the general release as a condition precedent to final payment from all road construction contracts. In other words, give the contractor a chance for a square deal upon a two-sided mutually agreeable contract.

Satisfaction Clauses

In most States it has been properly held that the satisfaction clause merely necessitates work satisfactory to the mind of a reasonable man. Thus if the work has been performed substantially in compliance with the contract, the law will hold the official, engineer, etc., to be satisfied. With plans and specifications so clear and concise as they generally are in road construction, and especially with the work required to be done "under the direction" of an engineer and under constant inspection, it would seem that legal satisfaction would be presumed in ninety-nine out of one hundred cases, and hence the use made of this requirement in such States would be merely to bluff or bulldoze the contractor. In no way does it improve the requirements of the plans and specifications.

In looking over many of the latest forms of road-construction contracts it is noticeable that there is a very decided improvement in the manner and method of setting forth the contract work and specifying what is variously designated as alteration, additional, miscellaneous, or extra work. In one such contract we find this definition: "Extra work is any work in connection with the execution or completion of the contract for which no price is included in the proposal sheets and contracts." Let us have definite contract units of work at unit payments clearly specified, and provide payment for any other work necessary which may arise either at the unit prices or, as is becoming popular, upon a percentage basis.

Duty of Engineer

The engineer should never forget that he is, under present-day clauses, taking the place of the court and that his action may close the door to either party to appeal from his decision. Professional honor and reputation often depend more upon the engineer's action in such matters than upon his pure engineering knowledge. However, the engineer must know that he cannot ordinarily deprive the contractor of his right to judicial construction of the contract after it has been performed so far as such construction involves matters of law. These considerations show us that the engineer holds under our present-day construction contracts an almost impossible position for a human being. Would it not be better to relieve him of some of these onerous duties? Experience seems to show that better feeling, better work, and co-operation between the engineer and contractor may be secured by more precise, concise and definite plans and specifications, and the elimination of all unnecessary "discretion" and "arbitration without appeal" clauses respecting the engineer.

The following instances where municipalities have been held responsible in damages on account of the actions and orders of officials and engineers should be known and avoided in the construction of contracts:

(a) Mistakes in lines, grades, elevations, plans or specifications or directions whereby the contractor had either to do additional work or do over work already done.

(b) Requirement that the contractor do the work in a way not called for by the contract, entailing more expensive work than would customarily or otherwise be entailed.

(c) Requirement that the contractor do over work already done properly or repair or maintain the same unreasonably.

(d) Requirement that the contractor do work not within his contract as contract work.

(e) Refusal to permit contractor to perform work called for by his contract.

Naturally the most important thing to the contractor is prompt payment, not only of his partial but also of his final payment. It is a general rule of law that a failure of a State or municipality to pay an instalment on the due date causes a breach of contract which relieves the contractor from further performance and enables him to collect the contract price or reasonable value of all work done to date. The failure of the engineer to make his estimate and issue his certificate may not excuse a failure to pay partial payments even if they are required to be made only upon engineer's certificates. The refusal of an engineer, under ordinary circumstances where there has been work done, to make his estimate and issue his certificate in time so that the contract payment can be made is of itself presumptively fraudulent.

Having considered these few most important matters and with an understanding of the legal principles involved, cannot we in the future have justice and equity, and not vengeance, spite or bossism in road construction work?

Concrete Roads

By Frank F. Rogers, State Highway Commissioner of Michigan

The State Highway Department, with the co-operation of the road officials of Wayne County and assisted by Prof. John J. Cox, instructor in highway engineering at the University of Michigan, has just taken up some detailed and rather minute observations of the Wayne County concrete roads which will extend over a period of years in the hope that a safe estimate can be made of the probable life and cost of maintenance of such pavements as the county is now building. The first records were taken for one continuous week, beginning Aug. 21, and have been preserved in the accompanying table.

A careful study of the variation in the percentage of defects for the different roads in connection with the age of the pavement will soon convince one that mere age has not produced the defects noted. For example, 252 sections built on Woodward Avenue in 1910 show but 27 per cent defective slabs, while 308 sections built on Grand River Avenue, the same year under the same specifications, show 50 per cent of defective slabs. There are two noticeable differences. Grand River Avenue was built by contract on a clay loam soil, while the portion of Woodward Avenue named was built by day labor under the direct supervision of the engineers of the county road commission on a soil more sand and presumably with a slightly better subdrainage. Again, 481 sections built on Michigan Avenue the same year with sand and pebbles for the aggregate and a 1:2:4 mix show 64.6 per cent of defective slabs. This was on clay loam soil. We might also mention 149 sections built on the River Road in 1910 on heavy clay soil, under the specifications last named, which show but 41.6 per cent. of defective slabs.

The most noticeable feature concerning these defects is that the longitudinal cracks always appear in groups, seldom singly. This indicates that there must be some local conditions in the foundation, due to insufficient drainage, soil conditions, newly made fills or uncompacted subgrades that cause these defects. Longitudinal cracks almost invariably appear on fills and on cuts, apparently with as much frequency in the latter as in the former. It would seem that cracks on the fills are due to the settlement of the embankment and in the cuts to the presence of water and frost in the sub-grade. If these causes could be thoroughly eliminated it would seem possible to build concrete roadways to the width of 15 or 16 ft., where sufficient expansion joints are used, without fear of trouble from longitudinal cracks.

It has been argued by the Morse-Warren Engineering Company, in a recent publication, that it is impossible to build concrete pavements (wider than 12 ft.) which will remain free from longitudinal cracks without using longitudinal joints, unless the pavement is so thick as to make the price practically prohibitive. The record of the 450 sections of 12-ft. roadway on the Fort Street road would seem to bear out this assertion, but a mile of concrete on the Eureka road shows a great number of longitudinal and transverse cracks in a 12-ft concrete roadway, where the soil conditions are the same as on the Fort Street road referred to. The only apparent difference is that the former is a 1:2:4 mix and the latter a 1:1½:3 mix, washed pebbles and sand being used for the aggregate in both cases.

But long stretches of pavement 16 ft. wide and now two years old on Grand River and Michigan Avenues, showing no longitudinal cracks, would seem to prove that a sufficient amount of money spent in compacting and draining the foundation or in reinforcing the concrete over newly made fills would produce pavements free from the objectionable longitudinal crease, whether natural or artificial. Most persons are agreed that transverse cracks are almost always due to defective expansion joints. It has been thoroughly demonstrated, both theoretically and practically, that 25 ft. is frequent enough for the expansion joints, and it is quite possible that they might be placed farther apart with safety—probably not less than three to 100 ft.

Many diagonal cracks were noted where the corners only were broken off, frequently on adjoining corners of adjacent slabs, indicating that the slabs were united through the expansion joints with a bond stronger than the tensile strength of the concrete on either side of the joint. In a few instances the holes noted are rather large, sometimes a square yard or more in area, but such places are very rare, and most holes are due simply to some foreign substances getting into the concrete, like clay, wood or some fragment of an inferior rock. This was more noticeable where crushed cobbles were used for the coarse aggregate than where washed pebbles were used.

Anyone familiar with the quality of rocks which constitute Michigan cobbles will understand that the principal objection to this material for an aggregate on concrete roads is the varying qualities of these rocks, ranging from soft to hard granite, quartzite and trap. A study of the roads where these materials have been used shows much more wear in the spots where the softer rocks happen to be at the surface.

Up to the present time the defects noted, except the pitted conditions of the concrete roads which have been resurfaced in the manner already described, are not serious and are not causing any additional expense for upkeep. In the last two years the expansion joints on all the old work, whether reinforced or not, have been coated with refined tar and sand once a year. Thus far the cost has ranged between $50 and $100 per mile, depending on the distance of the work from the base of supplies.

Data on Condition of Wayne County Concrete Roads

Name of road	Number of 25 ft. sections	Width, in ft. and in.	Depth, in.	Aggregate*	Mix†	Year built	Soil built on	Traffic count 24 hr. average 1 week	Per cent motor driven	Per cent horse vehicles	Defective sections: Longitudinal cracks	Transverse cracks	Diagonal cracks	Holes	Total number	Total per cent
Woodward Avenue.....	209	18	6½	*a*	1:2½:5 1:2 :3	1909	Clay loam	2160	88.1−	11.9+	80	32	2	46	160	76.5+
Woodward Avenue.....	252	18	6½	*a*	1:2½:5 1:2 :3	1910	Sand loam	.....	.....	.....	29	22	6	11	68	27.0−
Gratiot Avenue........	326	16	7	*b*	1:1½:3	1911	Clay loam	507	65.8+	34.2−	11	10	3	6	30	9.2+
Grand River Avenue....	61	18	6½	*a*	1:2½:5 1:2 :3	1909	Clay loam	1064	56.5+	43.5−	11	2	1	3	17	27.9
Grand River Avenue....	308	16	6½	*a*	1:2½:5 1:2 :3	1910	Clay loam	.....	.....	.....	59	20	29	46	154	50.0−
Grand River Avenue....	515	16	7	*b*	1:1½:3	1911	Sand loam	.....	.....	.....	13	26	3	6	48	9.3§
Grand River Avenue....	1208	16	7	*b*	1:1½:3	1912	Sand loam	352	66.5−	33.5+	70	44	13	5	132	10.9§
Michigan Avenue.......	481	17 8	6½	*b*	1:2 :4	1910	Clay loam	1009	67.5+	32.5−	219	48	23	21	311	64.6+
Michigan Avenue.......	1570	18 16	7	*b*	1:1½:3	1911	Sand loam	.....	.....	.....	219	80	42	14	355	22.6+
River Road............	149	15	6½	*b*	1:2 :4	1910	Clay	538	78.9+	21.1−	49	5	6	2	62	41.6+
River Road............	434	15	7	*b*	1:1½:3	1911	Clay	.....	.....	.....	165	17	13	0	195	44.9+
River Road............	213	15	7	*b*	1:1½:3	1912	Clay	.....	.....	.....	14	8	4	0	26	12.2+
River Road............	208	15	7	*b*	1:1½:3	1912	Clay	.....	.....	.....	17	9	0	0	21	10.0+
Fort St. Road..........	450	12	7	*b*	1:1½:3	1912	Clay	.....	.....	.....	0	19	9	1	29	6.5−

*Aggregate: *a*, crushed cobbles and sand; *b*, washed pebbles and sand.
†Mix: Where two combinations are given the first is that used for the base; the second, for the top.
§Corrected Sept. 22, 1913.

Treatment of Wornout and Raveled Macadam Surfaces

By Col. Edmund A. Stevens, State Highway Commissioner of New Jersey

Raveling is the loosening of the bond of a road surface until the constituent stone lies loose on the surface. Roads ravel from improper construction, overload or neglect. In all cases these affect the binder.

Poor workmanship in construction is generally shown by small local depressions in the surface from which raveling spreads, in certain cases at an almost incredible speed. In bituminous surface faulty material and thin spots generally show up clearly. In both cases the only remedy is to rebuild the work properly, if necessary, from the sub-base up. This is not strictly repair work.

In considering the effect of overloading and neglect it must be borne in mind that any given type of construction may be so maintained as to vastly increase its carrying capacity. As an illustration, assume in two cases the same foundation—let one road have a water-bound macadam surface dressed with a heavy bitumen forming a sheet about ½ in. in thickness, and the other a bituminous concrete (mixed method) surface of 2 in. The former will cost about 40 cents for stone and 15 cents for dressing, or 55 cents per square yard, and the latter about $1 (both exclusive of the foundation). With proper care the lighter surface will last about three years under fairly heavy traffic, the heavier one probably at least twelve years. The total yearly charges are then as follows:

YEARLY CHARGES PER SQUARE YARD

Bituminous Concrete	
Interest on cost, $1 at 4 per cent	$0.04
Depreciation, 1/12 of $1	.083
Labor (patrol)	.009
Materials	.008
Total	$0.14
Dressed Macadam	
Interest on cost, 55 cents at 4 per cent	$0.022
Depreciation, ⅓ of 15 cents	.05
Labor (patrol)	.019
Materials { ⅜ cu. ft. stone at 9 cents ⅛ gal. bitumen at 12 cents }	.0315
Total	$0.14

The fixed charges are 7.2 cents against 12.3 cents; the operating charges, 6.8 cents against 1.7 cents. These figures are simply illustrations of the principle involved. They show a great saving in operating charges, those that show up in the yearly tax bill. The fixed charges, however, are just as real and must be met at some date. For a road with 9500 sq. yd. per mile the costs as shown in yearly tax charges, where depreciation and interest are not visible, would in this case be $636.50 for the dressed macadam and $161.50 for the bituminous concrete, per mile.

Resurfacing should always be preceded by scarifying and by bringing the road up to the necessary depth of stone. For waterbound macadam needing greater surface strength several classes of chemical binder may be used, of which I shall discuss two—bitumen and lignin.

Bitumen applied by penetration is the cheaper, by mixing is the more trustworthy method. Which is to be used will depend on the estimate of the overload, as will also the depth of the bituminous sheet. My own observation leads me to question the wisdom of attempting to get any thickness exceeding ½ in. by penetration methods. It also leads me to prefer tar to asphalt, as it appears less sensitive to injury by dirt and to yield better results in repair work.

The lignin binders are derived from the waste products of wood-pulp or tannin manufacture, being also used to bind core sand in foundry work and impart a tensile strength to the binding materials. They will not act on materials soaked in the so-called road oils. The action of some of these materials on slag and red shale is quite remarkable. They are slightly soluble in water and will therefore need renewal. Their application, however, is easy and inexpensive and the effect of successive applications seems cumulative, increasing not only the depth of penetration but the strength of the bond.

For waterbound macadam roads that have failed through neglect a thin coat of gravel carrying some earthy matter or of screenings or coarse sand mixed with earth will usually cure cases that have not gone too far. In some of the counties of New Jersey it is usual to fill all ruts and depressions with fine stone and to give the middle of the road a coat of the same mixed with a little clay. Although the old ruts almost invariably reappear, this method is very successful in preventing raveling. It seems a false economy to omit rolling and wet rolling, at that. The same is true of patching holes with anything but macadam size stone. The roads treated with small stone are yearly losing depth. The moisture for wet rolling is usually bountifully supplied by nature in the early spring, and hygroscopic salts will serve in the absence of water. Traffic will usually throw off from the road surface enough stone to pay for rolling.

Discussion by Robert C. Terrell, State Commissioner of Public Roads of Kentucky

I disagree with Colonel Stevens in so far as he advocates the use of earthy materials as a binder, since earthy materials not only render the surface susceptible to retaining water but also permit the percolating of water into the subgrade. The tendency of waterbound macadam roads to ravel under heavy motor traffic may be largely overcome by increasing the size of the stone in the top course and using only a sufficient amount of screening and stone dust to cement the whole together after being thoroughly wet and rolled. The larger stone should be plainly visible on the surface, and the surface should have the appearance of a conglomerate rock that has been cut with a saw. Bituminous treatment of waterbound macadam is admittedly necessary. The heavy asphaltic oils have been used very successfully in Kentucky. However, the road to receive this oil should have been built at least six months in advance of its first treatment, in order to give the stone time to season or rid itself of the quarry sap. If the oil is not applied evenly, the surface will generally ravel or form potholes where the surface fails to receive the treatment. The road should receive one treatment of the oil each year, in the early spring.

I believe that Kentucky rock asphalt can be economically used for surfacing and for maintenance purposes anywhere within a radius of 1000 miles of the Kentucky field. The material of which I speak is a sandstone impregnated with about 10 to 12 per cent of asphalt, and is found in Edmonson County to the extent of 80,000 acres, ranging in thickness from 12 to 50 ft. In 1906 or about that time the United States Government constructed approximately ½ mile of road of this material near Bowling Green, which is now in an excellent state of preservation and shows little or no bad results from its constant and heavy use. It is safe to say that this material would not cost more than 80 cents per square yard in place anywhere within a radius of 500 miles.

Systematizing Purchase of Road Materials and Equipments

By Henry G. Shirley, Chief Engineer, State Roads Commission of Maryland

Under the purchasing system inaugurated in July, 1912, by the State Roads Commission of Maryland, a requisition is first made out in duplicate by a resident engineer, superintendent or a head of a department. The duplicate is retained by the maker for his files, and the original is sent to the chief engineer, who examines and approves the requisition or strikes out such items as he thinks are unnecessary. The requisition is then submitted to the chairman of the commission for his approval and then to the purchasing agent for his signature. After the purchasing agent has signed the requisition he immediately gets in touch with the material or machinery people and requests that bids be submitted by a specified time.

The requisition shows whether the material or equipment is to be used by the construction or maintenance departments; the contract number of the work on which such material or equipment is to be used; the person or persons to whom the article or articles are to be shipped, as well as the railroad station, section of road and the name of the county in which the road is located. The requisition also shows the quantity or number of items desired and gives a brief description of each. Satisfactory bids having been received, opened and tabulated, the contract is awarded to the lowest responsible bidder, and the order for material or equipment is made out. Printed instructions on the back of the order sheet give important directions to the consignee, including notice of cancelling option if the order is not filled within ten days.

With the order three identical bill forms are sent. The original bill gives the order number, the requisition number, the date of shipment, the name of the party to whom the shipment was made, the car number and initials, the name of the firm from whom the articles were purchased and the date on which the purchase was made.

It is required that the name and kind of equipment purchased be clearly and intelligently stated in the body of the bill, and no money will be paid out for material or equipment purchased unless the bill is made out in triplicate by the consignor on the forms furnished by the purchasing agent. When these forms have been properly filled out the original is forwarded to the purchasing agent, together with the bill of lading. The duplicate and triplicate bills are sent by the consignor to the person for whom the material or equipment has been purchased, who signs the duplicate copy, thus showing that the articles named on the bill were received, with the date on which they were received. He then at once forwards the duplicate bill to the head of the department, keeping the triplicate bill for his own files.

Likewise, the purchasing agent forwards the original bill to the head of the department, who certifies that the supplies were received on a certain date and that the quantities, quality and weights are as ordered. The original bill is then returned to the purchasing agent, who certifies that the articles shown on the bill were purchased under an approved requisition and that the account is correct. The bill is finally sent to the auditing department for disbursement, after the name of the county, the contract number, and the item number to which it is to be charged, have been placed on it.

Panama Water Supply

Workmen are engaged on the pump station and water-purification plant at Miraflores and at the high-service reservoir at Ancon, all parts of the waterworks which are to serve the southern end of the Panama Canal, according to the "Canal Record." The project includes three electric pump stations; a purification plant with an aëration basin, a headhouse for aluminum sulphate and hypochlorite of lime storage, mixing chambers, float chamber, solution tanks, controllers and electric elevator; a 5,000,000-gal. sedimentation basin; a filter plant with 14 rapid mechanical gravity filters, each of 1,125,000 gal. capacity per twenty-four hours, and an office and laboratory building.

Raw Miraflores Lake water will be screened and pumped to the aëration basin, where it will be thrown into the air, falling to the floor and passing to the mixing chambers. After aluminum sulphate is applied the water flows to the sedimentation basin, where it is detained eight hours. It then passes through the filters into the clear-water basin, whence it flows to the hypochlorite chamber.

New Engine Terminal of Baltimore & Ohio Railroad at Cumberland

Modern Layout Designed to Handle Mallet Locomotives; Submerged Cinder Pit with Traveling Crane and Plant for Three Sizes of Coal

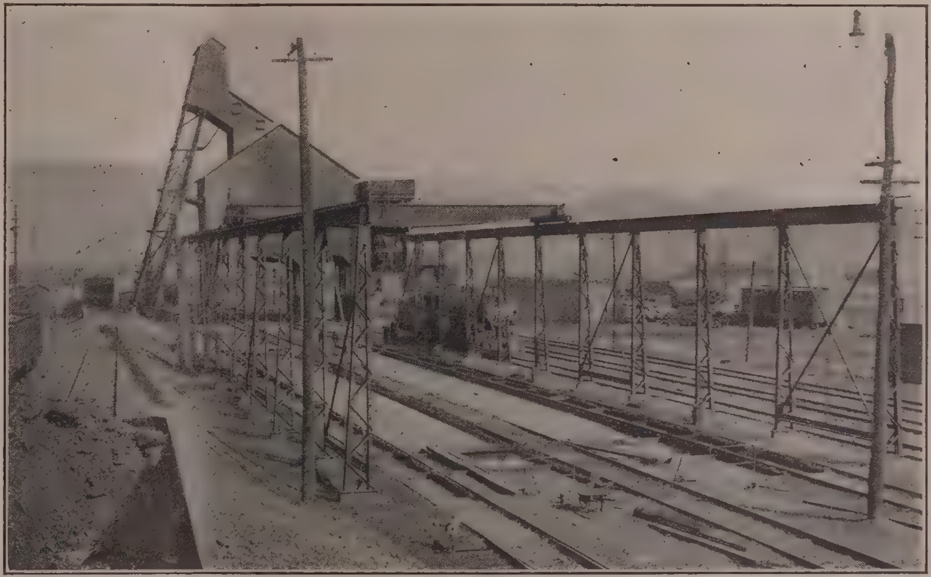
Cumberland is situated at the foot of the eastern slope of the Alleghany Mountains, near the convergence of the main lines from the west of the Baltimore & Ohio system, and is a division point for all through business. Both passenger and freight traffic are heavy, and practically all of the locomotives used are large ones—Mallets and Mikados for the freight service and Pacifics of the heaviest class for the passenger service.

The old engine terminal had become entirely inadequate for the proper care of the heavy locomotives, the situation being rendered more acute by the extremely cold weather that prevails for relatively long periods. The old house has only a 70-ft. turntable, and the stalls are only 90 ft. long. The accessories, such as cinder pits and coaling station, are more or less obsolete and are poorly arranged in several respects.

Sufficient ground space for the new terminal was available alongside the old, and the new layout is so arranged that the old house can be retained in service, utilizing the new pits and coaling station, and yet be replaceable at some later date with a house similar to the new one. The improvements made consist of a thirty-one-stall roundhouse, a double cinder pit, a reinforced-concrete coaling station and a small power house. Provision is made for future extension of the roundhouse.

Engine House

In order to accommodate the large Mallet locomotives the turntable is 100 ft. long and the stalls are 110 ft. The turntable is a deck structure. The house has brick walls on concrete foundations, with timber roof posts and beams supporting a wooden roof. The rear wall is made of brick pilasters with broad window spaces between, with top and bottom sash counterbalanced with each other. At the first row of posts, near the front of the building, the roof line is broken to give a row of sash with narrow vertical louvres over each stall to provide light and ventilation. Wooden rolling doors of an improved type which can be repaired at minimum cost are used. Each stall has a smokejack of Tram-mite, supported on a wooden frame, with hoods 4 x 12 ft. long.



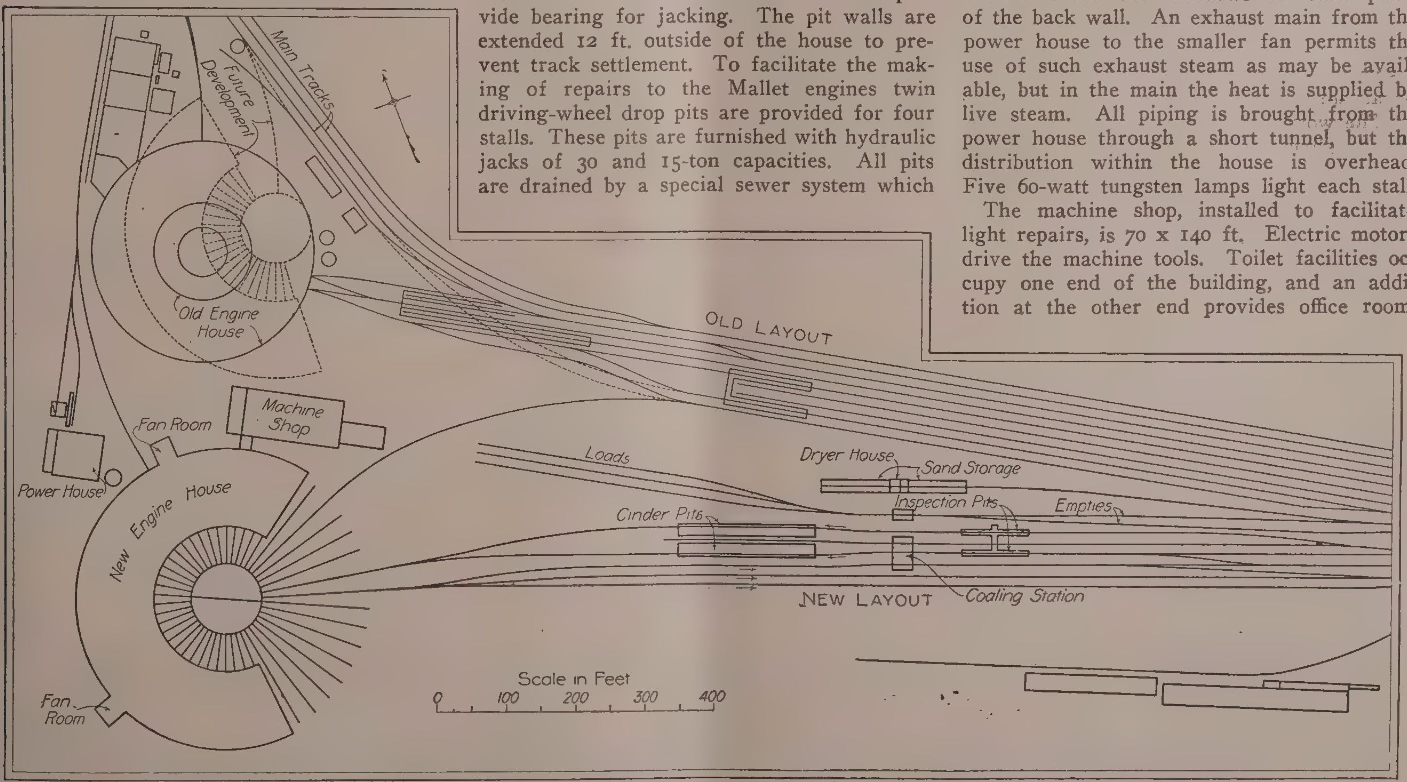
Cinder Pit with Traveling Crane; Coaling Station in the Background

The engine pits are made 88 ft. long, with the side pit walls for a distance of 40 ft. on the inner end made of sufficient width to provide bearing for jacking. The pit walls are extended 12 ft. outside of the house to prevent track settlement. To facilitate the making of repairs to the Mallet engines twin driving-wheel drop pits are provided for four stalls. These pits are furnished with hydraulic jacks of 30 and 15-ton capacities. All pits are drained by a special sewer system which returns the water to a central reservoir, from which it is taken for use in the boiler-washing system.

Two types of floor have been laid, one of creosoted wood blocks 3 in. thick and the other of mastic rock 1½ in. thick, both being underlaid with 6 in. of concrete. Equal areas of the two types were used, and they are expected to give an effective test of their relative merits.

The building is heated by an indirect system using one 200-in. and one 190-in. fan, with capacity to change the air in the house about once in fifteen minutes. One of these fans also supplies air for heating the adjoining machine shop. The main air duct encircles the house inside the outer wall. It is of concrete, with laterals of tile pipe leading to outlets alongside the wooden columns, there being three outlets in each stall. There are also two hot-air outlets under the windows in each panel of the back wall. An exhaust main from the power house to the smaller fan permits the use of such exhaust steam as may be available, but in the main the heat is supplied by live steam. All piping is brought from the power house through a short tunnel, but the distribution within the house is overhead. Five 60-watt tungsten lamps light each stall.

The machine shop, installed to facilitate light repairs, is 70 x 140 ft. Electric motors drive the machine tools. Toilet facilities occupy one end of the building, and an addition at the other end provides office room.



General Plan of Old and New Engine Terminals in Juxtaposition, with Possible Future Engine House Dotted

The power house is 67 x 65 ft. It contains two batteries of water-tube boilers aggregating 1000 hp, a 1000-ft. air compressor, a large fire pump, boiler washing pumps and electric transformers for power and lighting purposes, current being supplied from an outside source. The boilers have automatic stokers to which coal is delivered by gravity from overhead bunkers. The coal is dumped into a hopper outside and lifted with a bucket elevator to a belt conveyor, which discharges into the bunkers by means of an automatic tripper. Ashes are removed by manual labor.

Cinder Pit and Coaling Station

A view is shown of the cinder pit. It is a double pit of the submerged type, having an overhead traveling crane with a grab bucket. The pit is practically full of water at all times. The center track is the loading track for the cinders. About 120 engines are handled daily over the double pit, and one man working during the daylight hours only is able to load all the cinders.

Three sizes of coal are handled at the coaling station, which, as the general plan shows, is located in advance of the cinder pits. The bunker, which has a capacity of 600 tons, is divided into four bins; two of these are used for run-of-mine coal, of which there is the greatest consumption, and one each for coal crushed for locomotives equipped with stokers and special coal for passenger locomotives. Four tracks in addition to the cinder-loading track are served by the plant. Run-of-mine coal can be supplied to any of the tracks, while passenger coal may be taken on two of the tracks and stoker coal on a third.

The coal is received on the track at the north end of the plant. It is dumped from the cars into a concrete pit and elevated by the inclined balanced skip hoist shown in the background of the view of the cinder pit. The two skips are of 5-ton capacity each and will elevate 125 tons per hour. The electric motor operating the hoist is controlled automatically.

Provision is made for the overhead storage of 20 cu. yd. of dry sand, with suitable pipes for delivering sand to the locomotives on any of the four tracks. Storage is provided for about 1200 cu. yd. of green sand. The sand is dried by steam driers and elevated into overhead storage bins by compressed air.

The work was designed and constructed by Westinghouse, Church, Kerr & Company, of New York City, under the direction of Mr. M. A. Long, assistant to the chief engineer of the Baltimore & Ohio, as representative of the railroad company.

Comparative Coal Analyses

The results of analyses of 5000 samples of coal taken from 1500 coal mines and prospects in the United States coal fields are given in Bulletin No. 22 of the Bureau of Mines. The specimens were collected between July 1, 1904, and June 30, 1910, a uniform system being employed in collecting and analyzing.

The report contains the methods used and the results of analyses, and gives the exact location from which each sample was taken, with a description of the coal bed, the capacity of the mine and the manner of preparing the coal for market.

Because of the careful analyses under uniform conditions the data contained in the report are commended by the bureau to Government purchasing agents, designing and operating engineers and large dealers in coal.

Performance of Direct-Explosion Pumps in England

In the course of an investigation of water-supply and sewerage works in Europe during the last summer Mr. George E. Datesman, principal assistant engineer, Bureau of Surveys, Department of Public Works, Philadelphia, Pa., observed the Humphrey direct-explosion pumps in operation at Chingford, England, described in the Engineering Record of June 29, 1912. This plant is part of the Metropolitan Water Board's system for the water supply of London. The installation, which was completed in March, 1913, consists of four 40,000,000 gal. per day units and of one 20,000,000-gal. per day unit; the total capacity is, therefore, 180,000,000 gal. per day. The lift is about 31 ft. The fuel used is producer gas. Mr. Datesman's report, in part, follows:

Guarantees

The fuel consumption of the pump was guaranteed not to exceed 1.1 lb. of anthracite coal per actual pump-horsepower, a penalty of $5,000 being attached to every 0.1 lb. consumption in excess of this figure. The contract also provided a penalty of $100,000 should the plant prove a failure.

For an indicated capacity of 180,000,000 gal. per day, the price bid for the Humphrey pumps, inclusive of gas plants, buildings and foundations, was $95,000 less than the lowest bid for a triple-expansion steam engine centrifugal pumping plant. There was also an enormous difference in favor of the Humphrey pump in the guaranteed fuel consumption. Proposals for a sewage pumping plant at Leeds were received recently by Mr. George A. Hart on electrical direct-connected centrifugal pumps, on plunger pumps, and on Humphrey pumps. Mr. Hart examined the Chingford pumps and pronounced their action continuous and satisfactory. He also investigated their economy in connection with the 120,000,000-gal. plant proposed for Leeds. He finds that the electrical pump bid capitalizes at $0.004 per kilowatt-hour and that the Humphrey bid, together with the building and all accessories, capitalizes at $0.0025 per kw-hr; this figure includes cost of pump, power, building, operating cost and sinking fund. He favors the installation of the Humphrey pump at Leeds.

Performance

The Humphrey pump was put in operation at Chingford on March 15, 1913. Mr. Datesman inspected it after it had operated for a period of six weeks. From testimony obtained from the assistant engineer in charge of the installation, the assistant engineer of the Metropolitan Water Board and Mr. George A. Hart he found that the thermal efficiency is given as 22 per cent., that the guaranteed horsepower per pound of coal has been exceeded and that the output of the pump has been considerably in excess of the guarantee; 180,000,000 gal. were to be pumped, whereas more than 200,000,000 gal. is the output. He also found that the action is practically continuous and not, as one would be led to expect, a series of pulsations, and that as the exhaust of the pump is practically at atmospheric pressure, it makes no noise, except where exterior air is being sucked in through the valves. The larger pumps make six pulsations per minute.

The men employed are one foreman and two men on shift at the producer gas plant and one mechanic about the pumps.

The pumps were intended to discharge on a water cushion, but the actual effect is to scour the trough and to splash the water over the lip of the trough, a fault which is about to be corrected by the extension of the pipes so as to form siphons.

Mr. Datesman was impressed with the compactness, small number of castings and small space taken up by the units as compared with other pumps and motors. One other advantage is that almost the whole installation is below the level of the floor, which allows for a light pump house.

Conclusions

The application of the principle of direct explosion upon the liquid to be moved is economical because there is no loss through transmission and therefore its employment in pump design is attractive. The ability of a pump of this type to operate under heads in excess of 35 ft. is, of course, not established, but there is nothing to prevent this head being increased when larger units are installed. The economy in operation of this type of pump—taking into consideration the few men employed, the compactness of space, and the small number of parts to get out of order—is remarkable. When from actual proposals it is learned that a plant of this kind can be installed for about 35 per cent. less than the best electrical machinery, with centrifugal pumps, it affords an inviting subject for investigation, in view of the large pumping units which must be installed in the city of Philadelphia.

Artistic Character of Panama Canal Structures

Utility, simplicity and directness are the characteristics of the Panama Canal structures which made the most marked impression upon the committee of the Commission of Fine Arts which visited the Isthmus, in accordance with the provision of an act of Congress to report upon the artistic treatment of the canal and its appurtenant works. The committee, consisting of Mr. Daniel C. French, sculptor, and Mr. Frederick Law Olmsted, landscape architect, states in its recently published report that "the canal itself and all the structures connected with it impress one with a sense of their having been built with a view strictly to their utility. There is an entire absence of ornament and no evidence that the æsthetic has been considered except in a few cases as a secondary consideration. Because of this very fact there is little to find fault with from the artist's point of view. The canal, like the pyramids or some imposing object in natural scenery, is impressive from its scale and simplicity and directness. One feels that anything done merely for the purpose of beautifying it would not only fail to accomplish that purpose, but would be an impertinence."

Improvements Suggested

The approach from the Atlantic, the committee finds, would be improved by building the proposed breakwater and lighthouse on the left to match the structures already placed on the right side. The present appearance of the towns Colon and Cristobal is not pleasing. The crude effect of the large black steel water tank crowning Gatun, 3 miles beyond the head of Limon Bay, would be relieved were the tank incased in concrete. The Gatun Locks, however, are described as a broad, low, symmetrical mass of concrete and steelwork. The concrete, unless frequently painted, rapidly assumes a mottled, dark-green color in the Canal Zone climate. The steelwork will be painted the dark battleship gray.

Though the shores of the canal for 23 miles through Gatun Lake are beautifully forested, a distressing fringe of dead trees on either side calls for elimination. The lack of a market for the lumber and the expense of removal will probably prohibit such action.

The 8-mile Culebra Cut will, it is expected, improve artistically when the new banks become covered with vegetation. The steep rock cut near the center affords a striking picture.

Near the Pacific entrance there are many bold headlands and picturesque hills. Regret is expressed that a group of unimpressive navy-yard shops and docks close to the canal at Balboa should be so far advanced that changes can not be made.

Having treated in a general way the present appearance of the canal, Mr. French and Mr. Olmsted offer specific suggestions for improvements. A new design for the lighthouse to be built at the Atlantic approach was made at their request. It is recommended that the space opposite the statue of Columbus in Cristobal be kept free of docks and sheds.

If building conditions permit, some architectural feature more dignified than the small lights now planned should mark the point where the canal begins at Limon Bay on the Atlantic. If this be impracticable, the nearby beacon lights might be reduced to low structures resembling the illuminating buoys which mark the channel through Limon Bay; or lighthouses might be built on the first high solid ground on the Atlantic side, the Mindi Hills, near Gatun.

The concrete electric-light standards at all the locks would be less heavy-looking incased in sheet copper. The extremely broad overhang on the roof of the control building at Gatun Locks, a concession to the climate, should curve gradually, beginning at the wall, to gain distinctiveness.

The 3-mile causeway between East Balboa and Naos may become a favorite drive; but trees should not be planted so thickly along it that a view of the town would be shut off from approaching ships. Balboa itself is to be developed by the proposed erection of an administration building on a spur on the northwest side of Ancon Hill. This imposing structure is to face southwest. A 120-ft. main avenue parallel to this building will form the backbone of the reconstructed town. Shop employees will be housed on curvilinear roads connecting with the southwesterly end of this avenue. The employees in the administration building will have quarters on the slopes of Ancon Hill east and northeast of the main buildings, while the "silver" employees will be located south of Sosa Low Hill. This plan is, of course, still tentative.

The canal engineers and architects gave uniform assistance to the investigators and planned to co-operate in providing for the proposed changes.

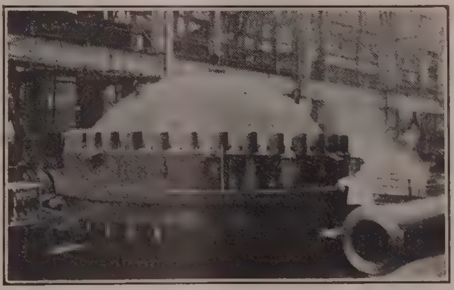
End of Dry Excavation in Culebra Cut

Steam-shovel operations in Culebra Cut were permanently suspended Sept. 10, according to the "Canal Record," and three days later all tracks except the incline tracks and one to the pumping plant had been removed. The following week the pumps just south of Gamboa dike, to free the cut from drainage water, were removed. It is estimated that 600,000 cu. yd. of material remain to be removed by dredges within the original limits of the canal prism in the Culebra section, exclusive of slides and the inclines. Excavation was begun in the Culebra Cut by the French in 1882 and has continued to the present time, with an interruption of only six years—from 1889 to 1895.

High-Pressure Aqueduct Shaft Cap

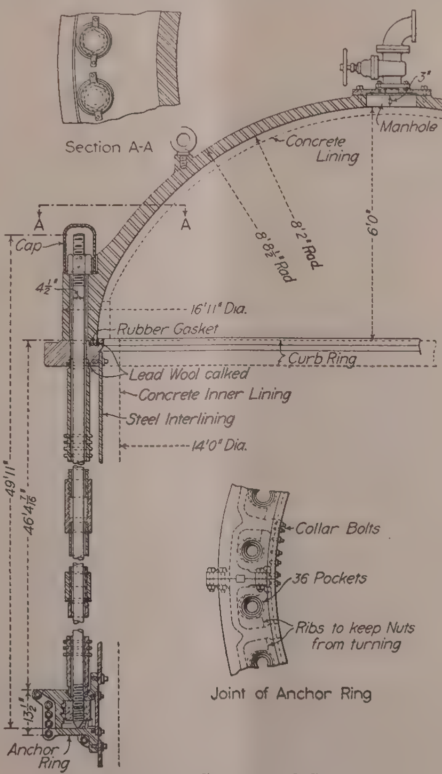
Removable Cast-Steel Cover to Resist Head of 410 Feet in Hudson River Siphon Tunnel of Catskill Aqueduct

To resist a hydrostatic pressure of about 2000 tons a removable cast-steel cap has been manufactured to close the top of one of the 1100-ft. waterway shafts of the great inverted siphon tunnel which will carry New York City's water supply from the Catskills underneath the Hudson River at a depth of almost one-quarter of a mile. Water will enter the Hudson River siphon through an aqueduct tunnel heading which taps the west shaft some distance below the surface and will leave the siphon at a similar connection with the east shaft. The west shaft, above the inlet connection, will be closed by a huge concrete plug, but the east shaft must be accessible for purposes of inspection and drainage. It was, therefore, necessary to design some form of cover for the top of the east shaft which could be easily removed and at the same time be capable of withstanding a 410-ft. head of water. Such a cover has recently been cast at the Midvale Steel Works for the T. A. Gillespie Company, contractor for the Hudson River siphon.



Finished Dome of Cover

The drainage shaft is 14 ft. in diameter inside the concrete inner lining, which protects the 15-ft. diameter steel interlining, outside which concrete is solidly packed against the rock. About 10 ft. above sea level this shaft is covered by a steel casting nearly hemispherical in shape. This dome rests on a cast-steel curb ring. To hold the dome in place against the pressure of the water when the aqueduct is in service there are thirty-six anchor bolts, each 4½ in. in diameter and 50 ft. long, made of nickel-chrome steel. These bolts go through bored holes in the flange of the dome and the curb ring and down through steel sleeves to an anchor ring about 46 ft. farther down. The object of these sectional steel sleeves is primarily to insure the application of the anchorage stresses at a suitable depth in the rock, and, secondarily, to permit the removal of the bolts, if desired, in connection with the removal of the cover, or for inspection, and also to protect the bolts from rusting by seepage water. The top and bottom sections of the sleeves are of cast steel with about fifty collars on the outside to afford a good grip on the concrete. The middle sections are galvanized pipes. These sleeves are later to be filled with mineral oil or some similar substance, as a further protection for the bolts.



Details of Cover and Bolts

The molding, casting, forging, machining and transporting of the dome, curb, anchor ring and bolts occasioned many perplexing problems. It took thirteen months of unremitting labor before the work was completed and tested.

Mold for Dome

The cover, or dome, naturally took the longest time to make. It had been decided that no pattern would be used for this, but that the shape would be swept out. To this end a large flask about 20 ft. square was built up of solid steel frames, or plates, in such a way that the structure would be rigid while pouring the casting, and allow the loosening of the bolts holding the frames together so that the casting during cooling could freely contract and shrink without danger of cracking. That the contraction of a casting of this size is considerable will be seen when it is remembered that steel shrinks in cooling about 3-16 in. per foot, or, in this case, about 3 3-16 in. in diameter and about 1⅛ in. in height.

The dome was cast with the concave side up on account of the heavy flange. A wooden sweep was cut to the inside contour of the dome and strongly mounted on a steel spindle. The flask was then filled with old molding sand to somewhat near the shape of the sweep; this was lined with new molding sand, well rammed and then swept to the exact size by rotating the sweep. The surface was then smoothed over and painted with a thin cement wash and covered with newspapers, as the shape in which it now appeared was to serve as a mold for the cope, and the papers were expected to prevent any adhesion between the surfaces. The cement also formed a very hard surface after being allowed to set in the air for several days.

About two dozen pieces of old gaspipe were built in as the work progressed to carry the gases away. About 11 carloads of sand were used in the mold and about 20 kegs of nails for studding the cope and as many more for studding the drag. The cope had about 20,000 lb. of metal in it and weighed, compete, about 240,000 lb.

The mold that had served for the cope was next dug out to a further depth, agreeing with the thickness of the casting, and a strip was bolted on to the edge of the sweep, so that it represented the outside contour of the dome. After thoroughly drying for several days, the parts of the mold were put together, after first locating several clay balls at different points of the surface. The cope was then lifted up again and the thickness of the clay balls measured. This gave the thickness of the steel casting at these points and showed that no deformation or sag had taken place.

Making the Casting

The casting was poured through two runners from two ladles. The capacity of one taken out and tested from runners, from coubut did not entirely fill the risers, so another ladle was brought on and poured 14,000 lb. more into the risers until filled. Everything was then loosened up to allow free contraction of the casting. The finished casting weighed 92,500 lb., the difference between this weight and the cast weight being mainly the twelve 15-in. diameter by 48-in. risers that rose vertically from the top to the rim, spaced about equally around. After having been left in the mold for twelve days the casting still retained very considerable heat, but was then cleaned on the inside, the outside clearing itself when it was lifted out to be put in a special annealing furnace that had been built alongside.

After a thorough annealing the casting was taken out and tested from runners, from coupons on the rim, and later from core drilling in four of the anchor-bolt holes. It took 14 weeks to machine the dome.

The casting sustained a hydraulic pressure of 250 lb. per square inch for twenty-four hours.

Transporting Casting

It had originally been the intention to ship these castings by team to the Delaware River and from there on barges by water up to Storm King on the Hudson by way of the Raritan Canal, as the railroads had claimed inability to ship them. But later careful measuring showed that by stowing the castings on special cars without bottom and allowing only about 4-in. clearance over the rails it would be possible to ship by the Pennsylvania Railroad by going a roundabout way, so as to avoid bridges. As it was, it was necessary to lower the tracks about 20 in. under a bridge just outside the works and at another place there was found a bridge where the castings in passing under took off a few bolts. The shipment was made on a Sunday by special engine. It took fourteen hours to get to Jersey City, as at times the cars, being so top heavy, would start oscillating, so that they had to be stopped until they had quieted down again.

New Type of Dressing Room

A unique dressing room for workmen has been installed at the coal-mining camp at Edgewater, Alabama, according to Technical Paper No. 33 of the U. S. Bureau of Mines. All clothing is first placed on trays and hooks and then elevated by chains and pulleys to the upper part of the room, where ventilation airs and dries them quickly, keeping the lower part of the room free from odor. In place of the unsanitary locker, each miner has an aerial clothes ventilator which may be padlocked in place. The floor space is thus freed of rows of lockers containing wet garments. The success of the scheme at the Edgewater plant suggests its applicability to construction camp buildings.

Study for Unification of All Freight Terminals at Buffalo—Part I

Discussion of General Problem and Details of Large Clearing Yard Proposed in 1904—Use of Cable Haulage for Hump Switching

It has long been conceded that the operating capacity of the average railroad is measured by the capacity of its terminals. In large cities, aside from the ever-present obstacles to expansion of high cost of additional land and opposition by the municipalities to necessary street alterations, there is the problem of providing adequate interchange between railroads. Buffalo is a city where this latter problem is a weighty one, and here, as elsewhere, unification of terminals is proposed. In a paper, from which these notes are taken, by Mr. George H. Kimball, consulting engineer, of Detroit, in the August "Bulletin" of the American Railway Engineering Association, he analyzes the situation and the proposed remedy.

Buffalo Terminal District

Located at the outlet of Lake Erie and fronting on the lake and the Niagara River, the lines of approach are confined to two general routes—one from the east and south, including the railroads approaching along the south shore of the lake, and one from the north, including the Canadian lines that cross the frontier at Black Rock and Suspension Bridge.

On the Canadian side of the Niagara River, opposite Black Rock, the following railroads converge to a common connection with the International Bridge: Grand Trunk, Michigan Central, Wabash, Pere Marquette, and Toronto, Hamilton & Buffalo. On the Black Rock side the yards of the following railroads lie practically parallel and just north of the connection with the International Bridge: Delaware, Lackawanna & Western, Grand Trunk, Erie and New York Central. Seventeen steam railroads converge at Buffalo, the large majority of which reach the heart of the city by their own lines and have their own terminals.

Large city terminals may be divided into three general classes, as follows:

(1) Seaboard and lake terminals, where all traffic is classified or its classification broken, for forwarding via the home line, or for distribution at the terminal, to or from connecting rail routes, connecting water routes, local industries or city freight houses and team tracks.

(2) Inland or all-rail terminals, comprising all the features of Class 1 except interchange with water routes.

(3) Intermediate or division terminals, where the terminal work of a large city and connecting lines combines with the work of two or more operating divisions.

The railroad terminals of the city of Buffalo naturally fall under the first head in the above-described classification. The essential problem at that point has not yet been solved, and it is probable that on the whole Buffalo presents the most difficult situation of any great city between Chicago and the seaboard.

The various lines of railroad in and about Buffalo connect and lie closely parallel at three widely separate points, forming an area roughly triangular. These points are Black Rock on the north, where the traffic via the north shore or Canadian lines crosses the frontier by the International Bridge; Blasdell on the south, where the south shore lines and lines from the south and east converge, and Lancaster on the east—the last-named point being directly connected with Blasdell by the Terminal Railroad of Buffalo (of the New York Central system), and with Black Rock less directly by the belt lines of the New York Central, Erie, and Delaware, Lackawanna & Western. These belt lines also serve as connections to and from the south, there being no connection for through freight movement from Black Rock south along or parallel to the water front.

Practically all of the Buffalo terminal facilities, including those serving the water routes, the local freight stations and the outer yards, lie to the south or east, the only exception being the yard at Black Rock and its connections, where the business is largely direct interchange, handled by switching movements to and from the outer yards in the southeast quadrant, and via the International Bridge.

Need for Clearing Yard

This brief survey of the Buffalo Terminal District, as it came to be known, presents the general features of the situation and makes understandable the conclusions, reached in 1904, of the Buffalo Freight Terminals Committee, made up of superintendents and other officials of the trunk lines affected. The conclusions embodied the following factors:

(1) The formation of a general switching association to be organized and equipped for carrying on all of the terminal work of the lines in interest.

(2) The combination, under the control of the proposed association, of all the terminal property and equipment required, or in any way necessary, for carrying on its work.

(3) The making common territory of the terminal territory of all of the lines in interest within the Buffalo Terminal District; that is, open terminals, with unrestricted interchange, and the same conditions to all concerned for similar service.

(4) Such arrangements of yards and connections as would divert through traffic from the congested districts, and prevent reverse and duplicate switching and interchange movements.

(5) The proper location, design and construction of a general classification and clearing yard of ample capacity for the needs of the time and capable of natural expansion without rearrangement or reconstruction to provide for future growth of traffic.

(6) The construction of auxiliary yards at Blasdell and Black Rock to provide for the interchange of traffic via the International Bridge at the last-named point, and for local freight for city delivery at both points, so as to avoid reverse movements.

In a word, these conclusions called for a unification of all railroad and water terminals, for a track system specifically designed to adapt means to ends to the fullest extent possible in the handling of freight traffic, and for an operating system capable of economy and dispatch. It was confidently expected that such a system would not only avoid congestion and provide for a more prompt movement than had ever been possible before, but that it would stimulate the growth of Buffalo as an industrial center, increase the local business, result in very great economy in terminal service and prevent the construction of additional belt lines by outside parties, with the assumption by existing railroads of the burdens an independent terminal involves.

In continuing the investigation statistics were compiled showing the maximum movement of freight traffic in and through the Buffalo Terminal District. These statistics were subdivided and classified in considerable detail, according to the requirements of the case. At this point the greatest problem of all involved in the general proposition, that of the location and conformation of the general classification and clearing yard, was taken in hand, and as the central or controlling factor in development was followed in detail to completion. To this work Mr. Kimball was specially assigned.

Location of Yard

By a process of elimination a location was at length decided upon just east of Lancaster. At this point four of the most important trunk lines lie within very narrow limits, are practically parallel for a long distance, and then diverge eastward. This fact, together with the existence of direct connections, beginning just west of Lancaster, and extending to Suspension Bridge, Black Rock (International Bridge), Buffalo proper and Blasdell, show this location, on the east point of the triangular area comprising the Buffalo Terminal District, to be the logical location for the general classification and clearing yard, the auxiliary yards at Black Rock and Blasdell being located at the opposite angles of the triangular area referred to.

The details of various minor problems, with reference to changes in existing tracks and connections to permit direct movements in diverting trains outside of the congested district, were worked out in connection with the problem of locating the clearing yard. Due consideration was given to the direction of the yard with reference to prevailing winds and the probable effect of extreme weather conditions.

The design of the classification and clearing yard was controlled by factors and conditions far greater in number and magnitude than in any work of the kind previously attempted, and so far as known, attempted up to the present time. All of the freight traffic passing the Buffalo gateway, except local freight from the west, was to be provided for, as well as all of the work performed in receiving, classifying and delivering city and industrial business, lake freight and interchange, including car repairs, the care of the engines and light repairs to same.

General Method of Attack

As there was no precedent to follow, the problem of design became one of making the best adaptation possible of known principles and appliances to larger needs. The method was followed of designing the essential features of a track plan without regard to road lines, land lines, topography or any other possibly limiting object, and then adapting it to the location desired. This proved a very satisfactory way.

For obvious reasons it was necessary to carry on the work with secrecy. No surveys were permissible, and the information required was compiled as far as possible from existing maps and profiles, with such detached measurements and special observations as were possible under the circumstances to check and unify the whole.

A classification and clearing yard is a composite affair and comprises an extensive group of closely connected and inter-related yards. The first division is determined by the opposing movements of the traffic, which, in this case, is substantially balanced so far as the general capacity of the yard is concerned, thus requiring an eastbound and a westbound yard practically identical in arrangement, except that the eastbound yard must have the added feature of stock yards and icing stations. Thus the general design became two parallel hump yards identical in plan, but reversed as to direction of movement of traffic. The humps were located as nearly opposite as possible to permit the ready transfer of engines and car riders from one yard to the other in order to equalize the number of engines and the force of men required under varying conditions of traffic.

Yard Units

The eastbound yard must have a capacity for handling 5000 cars in each 24-hour period. It will consist of a receiving yard, a classification yard, a repair yard and a forwarding yard, all arranged in linear order from west to east, so that a forward movement in the direction of the traffic is provided for with the possible exception of repaired cars. Stock yards and icing stations are provided for in connection with this yard, but are separately operated. Facilities for caring for and handling engines and cabooses, for fuel and water supply, car repairs, and all of the numerous details that go to make up a complete terminal are included.

To handle 5000 cars per day will require the regular service of two engines working over the hump, and this suggests a track system divided longitudinally into two sections for convenience in working, but so connected that they are in effect one yard. This feature, the requirements of classification, and the fact that the eastbound lines in interest diverge at last to right and left (north and south) make it feasible and desirable to separate the eastbound lines into two groups and assign to them sections of the classification yard and forwarding yard to right and left of the center line. This longitudinal division is carried out for the entire length of both eastbound and westbound yards, but the sections are so intimately connected that all of the cross movements that can possibly be required are provided for.

Receiving Yard.—The receiving yard is divided transversely by slip switches into two sections, a receiving section and a hump section, and each consists of two parallel groups of tracks with twelve tracks in each group. The exterior tracks of each group are reserved for thoroughfare tracks and are not included in estimating the capacity. It is assumed that a partial classification can be provided for in the make-up of incoming trains. This separation is feasible and desirable, and can be made by trains or by groups of cars in trains. It is not unreasonable to expect that in view of the large amount of classification work to be performed by the clearing yard, the lines in interest can establish rules requiring inbound trains to be made up with solid groups of cars for lines connecting through the terminal.

Engines will "feed" cars from the receiving section to the hump section of the receiving yard as fast as tracks in the latter section are cleared by the hump engines, or all engines can be worked in a circuit, including the receiving section and the hump section. A total capacity of 3750 cars is provided for the combined receiving and hump sections.

Classification Yard.—The large number of classifications to be made here make it imperative to provide yards for classification purposes exclusively, so that cars can be grouped in cuts, on tracks provided for each road and its principal stations and junction points, these cuts to be run to the tracks in the forwarding yard in the order determined for made-up trains. A separate group of classification tracks is provided for each hump engine, with connections at both ends with the classification group opposite.

There are sixty-five classification tracks in each group; that is, 130 classification tracks in the eastbound and a like number in the westbound yard. These groups are divided longitudinally by tracks reserved as thoroughfare tracks into secondary groups, and one group is assumed to be assigned for each road for which trains are to be made up. The plan is perfectly flexible, as any track can be designated as a thoroughfare track for this purpose, and the number of tracks in each secondary group can thus be made to suit unequal or varying requirements. The capacity of the receiving yard is 2200 cars.

Track Scales.—Track scales are located just over the hump at the head of the classification yard on independent tracks with grades adjusted to suit the service. There are two scales, one for each section of the classification yard, with tracks and connections so arranged that either scale can be used to weigh cars for either or both divisions of the classification yard as required. These scales should be 75 ft. in length, with all modern attachments, the device for automatically recording the weight being particularly necessary.

Repair Yards.—Repair yards with a working capacity of 1060 cars and additional holding capacity of 900 cars occupy the space between the classification yards and the forwarding yards. The grade falls slightly in the direction of the traffic, so that cars can be easily moved by hand or with a cable and stationary power. The yard is divided into a holding section, a working section and a section for repaired cars. In the working section the tracks are spaced alternately on 15 and 25-ft. centers. The wide intervals are intended to include standard-gage service tracks for handling wheels and repair materials. The length of track per car under repair is figured at 45 ft. In this section groups of tracks are provided for (1) first-class or time freight; (2) second-class or slow freight; (3) light repairs, such as wheels, truck repairs and draft rigging; (4) medium repairs, such as ends, end sills, etc., and (5) heavy repairs. Transfer tracks and platforms are also provided.

Forwarding Yards.—There are two forwarding yards side by side, each composed of two groups of twenty-five tracks each, with a total capacity of 9200 cars. The exterior tracks of each group are reserved for thoroughfare tracks and are not included in estimating the capacity. These forwarding yards are to be further divided under working conditions into smaller groups of tracks by assignment to the different railroads, according to their requirements.

The relatively large capacity of the forwarding yards is noticeable, but the only proper place for the prolonged holding of cars is in the forwarding yard in made-up trains ready for road movement. To insure smoothness, certainty and consequent capacity in the working of a hump yard the receiving end should be kept practically clear—that is with the traffic moving freely through it, particularly in cold weather—and should never be allowed to fill up to check the movement except in some serious emergency.

Caboose Yards.—The location of the caboose yards is shown between the extreme ends of the forwarding yards, the intention being to handle the cabooses with electric motor cars. This location provides for putting cabooses on made-up trains in the forwarding yard or as they pull out of the forwarding yard, and it has the advantage of separating the movement of cabooses from all other movements to the greatest extent possible. Accommodations for 100 cabooses each way are provided.

Profile.—The profile adopted provides an accelerating grade with a fall of 5 ft. in the first 150 ft. from the hump. This will give, if the cars are uncontrolled, a velocity of about 12 miles per hour under normal conditions. A uniform grade for the classification yard follows; it should be from 0.6 to 0.7 in order to start the cars by gravity to make the run to the forwarding yard. The grade beyond the classification yard can then be reduced to 0.5, 0.4 and 0.3 per cent.

Trolley Tracks.—Provision has been made for a double line of trolley tracks in the central space between the longitudinal sections of both eastbound and westbound yards. These tracks will extend from a point near the hump to the extreme ends of the forwarding yards, and will be constructed in subways where cross connections are made between adjacent sections of the yard. These facilities provide for prompt handling of car riders on the return trip to the hump.

Engine Facilities.—Provision is made for the continuous forward movement of road engines from the time they are cut off from trains in the receiving yard until they reach successively the coal dock, ash pit, engine yard and outbound trains, the engines being turned in the process without the use of turntables. In the course of this circuit they pass between and under the humps. There is no interference with other traffic, nor is the engine movement interfered with. While the distance to be covered by engines in making this movement may appear to be considerable, the time element is the real factor, and on this basis the design proposed has every advantage.

A sufficient number of tracks are provided in the engine yard so that the engines of each road can be assigned to separate tracks. This detail is necessary to facilitate the outward movement of various classes of engine service, as well as for the different roads. After entering the engine yard engines will pass through a house and over pits, arranged for thawing out when necessary. Fuel storage is provided adjacent to the coal dock. These facilities have a capacity sufficient for the roads in interest and the plan is capable of natural expansion to include other lines as well.

Stock Yards and Icing Stations.—Stock yards and icing stations are arranged in two groups in order to avoid reverse movements and grade crossings; this also favors the division of the traffic by roads as it diverges east from the clearing yard. One lead track for this section of the yard can include a low hump for sorting purposes if necessary.

Power House.—A centrally located power house is required as a source of compressed air and electric power, light, heat and water supply. It must be of relatively large capacity, provided for ready expansion, and contain all of the modern appliances that contribute to economy and efficiency.

Interlocking and Lighting.—The interlocking of this yard will be divided into sections, determined by the divisions of the yard and the service requirements. The two longitudinal divisions of the classification yard will be separately interlocked, and will be controlled by independent signalmen at the hump, and will be interlocked as between the two main longitudinal divisions at points of connection so that the co-operation of the signalmen will be required to make cross movements. Not all switches or groups of switches need to be interlocked, but all switches should be moved by electric or pneumatic power from central stations, and all switches should be electrically lighted.

Arc lights are to be provided for all switch leads, thoroughfare tracks, engine tracks, ash pits, coal docks, etc. Compressed air supply and testing plants are required for the repair yards and for testing made-up trains, also for testing and power purposes in the repair shops. Pneumatic tubes are included for the transmission of way bills and for similar purposes.

Miscellaneous Facilities.—A complete telephone system is essential and has been included in the estimate of cost. Particular attention has been given to the question of drainage, both natural and artificial, and provision has been made for an ample supply of good water, with a standpipe to provide pressure for distribution and a storage reservoir to tide over any emergency. The mains of the Depew & Lake Erie Water Company can be readily extended to the location chosen for the storage reservoir.

Ample provision for fire protection has been made at all critical points, and special provision for apparatus on cars and for the general equipment of switch engines.

Cable Haulage

Throughout the investigation the question of the possibility of increasing the capacity of hump yards was kept constantly in view. The hump is the limiting point, and its efficiency, as determined by the design and the operation at that point, determine the capacity of the yard. Everything depends upon this factor in the problem and it is, perhaps, ordinarily the weakest link in the chain.

To insure the continuous service of two switch engines at one hump, four tracks were provided, designed to be operated in pairs, operating the opposite tracks of each pair alternately, thus keeping up a steady movement of two lines of cars over the hump, by bringing in a second line of cars on the opposite track of each pair, while the first two lines of cars are being classified; that is to say, that it would take four switch engines to keep up a continuous movement over the hump. The four-track arrangement also minimizes the effect of derailments, as it is improbable that more than one track would be thus obstructed at any one time. Beyond this, however, extreme weather conditions sometimes defeat all calculations, and in a yard of this character it is desirable to be free from the effect of high winds and sleet, if possible, as well as to increase the normal capacity at the hump.

Studying these points, Mr. Kimball at length hit upon the plan of a modified cable haulage system. It was manifest that with the weight assumed to be handled, 50 cars, estimated at 2250 tons, applied at one point on the cable, the "grip" system was useless, and it was found necessary to insert in the cable a heavy link of special design; as such a device could not be operated over the drums of the winding machinery, provisions were made for reversing the movement of the cables, and here the four tracks over the hump fitted into the plan as well as before, as cars could be moved on one track while the cable was being reversed on the other.

Special cars were designed for picking up the cable by means of appliances operated by compressed air, these cars to be held by brakes on a short switchback grade from which they would run out by gravity behind a cut of cars pushed up from the lower end of the receiving yard, and dropping back by gravity to the starting point. The eastbound yard on the accompanying plan shows the track arrangement as proposed for cable haulage.

This application of stationary power would, in Mr. Kimball's judgment, practically double the capacity of the clearing yard, without any other change in the arrangement or increase in its facilities. The plan practically eliminates the effect of weather conditions on the ascending side of the hump, and the power is more reliable, economical and under better control. In applying it, all the tracks in the hump section of the receiving yard are omitted except the four tracks passing over the hump, and these remain exactly as before. A constant movement over the hump of two lines of cars could be maintained at an average speed of not less than 5 miles per hour.

The foregoing investigation was concluded in 1904. In the next issue a diagram of the main units of the yard as proposed will be presented, together with an abstract of Mr. Kimball's comments up to July of this year on the situation.

(To be concluded)

Pneumatic Ash-Handling Test

A test of the pneumatic ash-handling plant at the Sixty-eighth Street pumping station in Chicago is described in the report of the Department of Public Works for 1912. The system comprises a Green rotary positive pressure blower, belt-driven by a General Electric continuous current motor, and an 8-in. conveyor pipe, which carries the ashes from flat hoppers in front of the seven boilers in the station to the separator tank, from which point an 18-in. exhaust pipe leads to the dust collector. The conveyor duct consists of 212 ft. 6 in. of horizontal pipe, 45 ft. 6 in. of vertical pipe and four 90-deg. elbows of 15-in. radius.

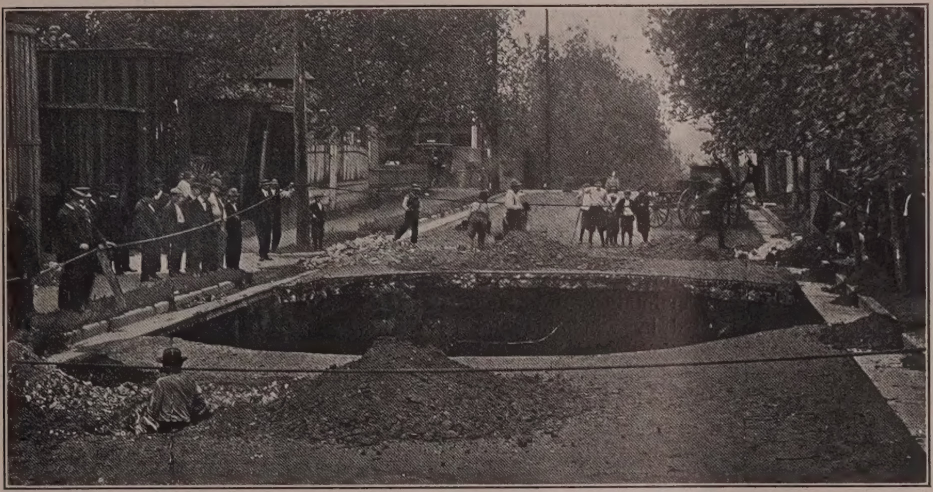
A test was first attempted on Oct. 29, but imperfect results were obtained because the wear plates at the elbows of the tested boiler were worn through, causing leakage of air and reduction of velocity. On Nov. 8 a successful test was made. Ashes from the boiler were weighed in a box on correct platform scales, after which they were hoed into the opening by a representative of the contractor. At boiler No. 2 655 lb. of ash were fed into the conveyor in two minutes, which is at the rate of 327 lb. a minute. However, as these ashes weighed 44 lb. per cubic foot and as the boiler is at the far end of the conveyor pipe, several seconds elapsed before they were carried through. At boiler No. 6 the ashes were lighter, averaging 38 lb. per cubic foot; 894 lb. of this ash were fed to the conveyor in two minutes and fifty-five seconds, and were at once carried through. The results, showing that heavy ashes were carried from the far end at the rate of 327 lb. per minute and that light ashes were carried at the rate of 307 lb. per minute, satisfied the city's mechanical engineering representatives, Messrs. C. E. Fitch and H. A. Allen.

A Tall Brick Stack has been erected for the J. Heinz Company, of Northside, Pittsburgh. The stack is 250 ft. high and tapers from a 23-ft. base to a 10-ft. top, according to the "Industrial World." Sixty-four concrete piles were driven 30 ft. for a foundation. Alternate courses of the brick are headers, and heavy steel bands have been inserted in the masonry at seven stages to provide for temperature changes. A similar stack, 60 ft. away, is soon to be built.

Collapse of Sewer in St. Louis

A large circular brick sewer located 44 ft. below the street level collapsed on the morning of Sept. 20 at St. Louis, causing a cave-in of the street. The sewer runs east and west and extends from Penrose Street and Obear Avenue to the Mississippi River, a distance of approximately 1½ miles. The cave-in occurred on Ferry Street between Fourteenth Street and Blair Avenue.

The sewer, according to information received from Commissioner C. A. Moreno, was constructed in 1878 of brick laid in lime mortar, no cement being used. At the point of collapse the sewer is 5 ft. in diameter, and the lime mortar in which the bricks were laid had been gradually disintegrating and falling into the sewer, until finally the arch broke down, permitting the earth above it to drop into the opening. This earth was gradually carried away, forming a large subterranean cavity. As the surface of the pavement remained intact, the damage was not discovered until a section of the pavement and sidewalks, about 35 ft. in width and 65 ft. in length, broke down. This accident fortunately occurred between midnight and 5 a. m. and resulted in no personal injury or loss of life.



Hole in a St. Louis Street Caused by Collapse of a Sewer

Two days later, while repairs were under way, a 36-in. water main in the vicinity burst, discharging about 4,000,000 gal. of water in the course of a few hours. The water main was located within the drainage area served by the sewer. The entire discharge was precipitated into the sewer and quickly found its way to the cave-in. The sewer being clogged at this point by débris, the water was unable to flow through and filled the hole to within a few feet of the surface of the street. The water was also backed up into the lateral sewers west of the cave-in, filling the manholes up to the street level. The pressure finally became great enough to force an opening through the blocked portion, causing additional damage and increasing the size of the hole to a width of 50 ft. and a length of 110 ft.

Owing to the bad material found at the bottom of the cave-in, the extreme width of the hole and its irregular shape, the ordinary system of cross-bracing, by means of which cave-ins of this character are usually repaired, could not be followed. A row of piles was, therefore, driven across the opening on either side of the collapsed sewer before the necessary earth could be removed to enable the reconstruction work to proceed. This work is now well under way, but it is feared that the great pressure to which that portion of the sewer west of the cave-in was subjected by the bursting water main has greatly weakened it, and it may be that a considerable portion of the sewer will be found to have been damaged to an extent necessitating reconstruction and repairs.

Letters to the Editor

Asphalt Paving Cements

Dear Sir: As a subscriber and diligent reader of your valuable paper for a considerable period may the writer be permitted to compliment you on the extraordinary amount of matter concerning highway engineering which you presented to your readers in your issue of Sept. 27, and to indicate his appreciation of your selection of articles of such great interest? As a highway engineer of continuous experience of many years the writer would further like to specify the points you made that appear to him worthy of especial interest and to suggest a few queries that are inspired by some of them. Your editorials "On the Other Man's Shoulders," "Seeing Is Believing," "Permanent and Impermanent Elements of Roads," and "Principles versus Practice in the Teaching of Engineering" are unquestionably worthy of careful digestion.

The articles referring to concrete roads inspire some questions. You comment on page 338 on the "$6,225" expended by Wayne County last year for "supervision" over work aggregating nearly $600,000. This is indeed a remarkable record and one which would warrant the publication of the details as to how this supervision account is made up. Later in the article on "Hard Roads in Wayne County," on page 340, it is stated that even the experienced workmen "are continually watched by the inspectors," and that "three elected commissioners supervise the construction" with a "chief clerk and three assistants." Then there are two engineers and an assistant engineer, with two helpers and a paymaster, foremen and timekeepers. If $6,225 per year covers all the salaries and expenses of this force, the county should be ashamed of its rates of pay. If it covers only a part of such salaries and expenses, then may not an unfortunate impression be had by readers of your comment on this low cost for "supervision"?

The writer has seen many articles—some in the Engineering Record, he believes—arguing for the provision of proper salaries to be paid engineers. It has frequently been necessary for him in his practice to fight for adequate compensation for his subordinates and for the organization he has recommended to his clients. Such fights are made more difficult when the other side can refer to the Engineering Record as stating that work may be well done with only a "supervision" charge of about 1 per cent of the total expenditures. Personally he thinks the expenditure of the Maryland Roads Commission of $4,500,000 during 1908 to 1911 inclusive, with overhead charges aggregating less than 4½ per cent—all as set forth in detail by the report of that commission—is nearly the record for economy in such matters; but in the unfortunate absence of details as to the Wayne County "supervision" it is difficult to ascertain the facts. All of this matter has been raised by the writer previously before the American Society of Civil Engineers and the present instance only serves to illustrate the points he then made.

The article on "Asphalt Paving Cements and Road Binders," by Col. J. W. Howard, was read by the writer with his usual interest in anything the author has to write or say. In a general way the idea of the author to simplify, as far as practicable, the specifications for such materials and the omission of unnecessary clauses are to be endorsed, although it seems to the writer that the author's suggestions are themselves open to the criticism of being needlessly profuse. For instance, from his list on page 345 could not clauses 1 and 4, 3 and 9, 5, 6 and 7, and 10 and 11 well be combined into four single clauses? But the author and many others who are advocating a simple general specification for such materials seem to the writer to omit consideration of another side of the situation frequently existing, which is this:

The various materials offered by the manufacturers have, from their source of supply or from their methods of manufacture, individual characteristics. The local conditions in any cases of their use are seldom identical. Economy and efficiency are generally desirable, if not controlling, in each case, and a proper selection of the particular material best fitted for that case is necessary. "The scientific selection of pavements" has been proposed and discussed by others, as well as by the writer elsewhere. Suffice it to say here that there can be little doubt but that selection from the list of bituminous materials available is frequently desirable.

Public officials usually are required to have some plainer means for making such selection than their opinions, no matter how eminent the latter may be. The rights of "the lowest responsible bidder" are sacred to the public. If the specifications are open enough to admit all good materials, then the official in charge is precluded from selecting the better material at a higher price and a monopoly for the lowest-priced material is unavoidable.

A convenient avenue for a public official to provide toward the end of giving him some chance for selection of the material is therefore given by drafting the specifications for asphaltic paving cements and road binders so as to divide them reasonably into classes. This gives the official the opportunity of selecting beforehand the class on which bids are to be asked; it furnishes a market, subject to the control of the officials, for the higher priced materials, encourages competition in improving the characteristics and in reducing the costs of manufacture so as to enable a material to be recognized as admissible to as many classes as possible, and, finally, may require, for the present at least, the presence frequently of just such clauses in the specifications as are objected to by Colonel Howard, such as the specific gravity, paraffine, sulphur and other requirements.

The writer does not mean to take issue with either the Engineering Record or Colonel Howard in the matter, but merely to present, as suggested in your editorial on "Tests for Asphalt Cement" another side of the problem, so that the light ultimately shed on it may be the most searching.

W. W. Crosby,
Baltimore. Consulting Engineer.

Fitting Engineering Students for Industrial Management

Dear Sir: Your editorial entitled "Fitting Engineering Students for Industrial Management" in the issue of Aug. 16, page 170, is written in a manner suggesting that the writer had very well-defined personal opinions on the subject and may be able to point to many instances where the sort of training described was successfully applied or else keenly sought.

It may be of interest, therefore, to the writer of that article to note the experiences of men now in the field with that sort of training. I have secured in substance the training which it is proposed to give, though at the cost of far more time, effort, and money than the proposed four-year course. I am a graduate of a leading civil engineering college, with five years of experience of the most varied sort—all on large projects where the economic element in engineerng was prominent. I studied at one of the largest law schools in New York City and am a member of the Bar. I believe, therefore, that I can regard myself as possessing the equivalent of the training it is proposed to give, particularly so as in addition to law and engineering I have devoted considerable time to statistics and accounting and have been offered a position as statistician in the State service, and have further added to the experience outlined by the Massachusetts Institute of Technology committee by spending some time in the Patent Office at Washington as examiner of patents.

Although possessing the qualifications which it is alleged are in demand, I have never had any offer which even remotely suggested the prospect of using this sort of training, and further have been unable to find a means of locating the people who are alleged to be looking for my type.

However, the purpose of this letter is not to recount my own experiences save in so far as they illustrate the fate of the men who have hitherto sought to find the reputed unfilled line of vacancies. Personally or indirectly I know no less than a dozen engineers who possess both the engineering and the legal training, and all probably had the intention of working into executive lines, but none has gone into those lines. Two or three abandoned engineering and devoted themselves to law work exclusively; one reports he never handled an engineering-law case; the others handle more or less engineering-law work. A man of my acquaintance, who possibly handles more engineering-law work than any other holder of the two degrees, devotes only a part of his time to engineering-law cases.

One of these dozen men held an executive position with a railway before he went into law; after finishing his studies he drifted into pure law—not back into executive work. Two or three of the men have gone into patent law and are doing well—using their engineering education only as a scientific training, and not as industrial engineers.

Finally a study of the biographies of our leading professors in engineering colleges will disclose a considerable number who hold law degrees, and in some cases even are the authors of books on legal topics. The fact that they are not in industrial engineering would seem to be good basis for saying that there is at present no real demand for men trained along the lines suggested.

In concluding that there is no demand for men trained along the suggested lines I do not mean to deny that there is a limited class of men who are so placed that they will inevitably have a business to look after. Such men could use the proposed course no doubt to advantage better than a detailed engineering course; but it should be clearly recognized that the possession of the training is of value only to a man so peculiarly situated and is not to be recommended as a general course.

New York. Lex et Scientia.

"Pond-Week" Fallacy

Dear Sir: The building of ponds, referred to in the editorial on page 253 of the Engineering Record of Sept. 6, has gone past the experimental stage in the State of Kansas. We have just passed over the dryest season experienced in the State since 1860. Many ponds went dry, and rivers also stopped running. The fact that a great many of the "sky ponds" went dry is no reason why they should not be built and maintained. Most of the ponds that were fed by windmills and springs held out through the dry spell, as did a great many of the sky ponds. Many of these furnished water for a long time before they failed. However, when rivers, springs and good wells failed, it is not to be wondered at that many of the ponds gave out.

The pond-building business in the State of Kansas is managed, for the most part, by the engineers at the Agricultural College and at the State university. The Department of Fish and Game also has a resident engineer on the ground, so that the pond business is not a haphazard business. It is being done largely under the direction of competent men. The Governor and many other good citizens having observed the value of ponds in different parts of our State during the dry spell, have, and, in my judgment, wisely, considered that a "pond week" would call the attention of a very considerable number of people to the value of ponds. After the people once understand that ponds are valuable, many of the farmers will undertake to build them.

The Kansas State Legislature, which is made up to a very considerable extent of farmers and business men, passed a law at its last session exempting a certain amount of land on each farm from taxation, the amount exempted depending upon the size of the pond to be built on the farm.

The State Department of Fish and Game has issued bulletins on pond and pond-fish culture.

L. L. Dyche,
State Fish and Game Warden.
Pratt, Kan.

Dear Sir: I have read the editorial on "Pond-Week Fallacy" in your issue of Sept. 6 and am sending you a copy of "General Directions for Earth Reservoir Construction," which we have just got out, a blueprint of suggestive plans for earth reservoirs, a bulletin on "Ponds, Pond Fish and Pond Fish Culture," by the State Game Warden, Professor Dyche, and a bulletin on the "Use of Windmills for Irrigation in the Semi-Arid West," published by the Department of Agriculture, Washington, D. C. This is the general information we are furnishing farmers and others who make inquiry in regard to the construction of ponds. Where the farmers request us to make personal inspection of the proposed reservoir sites we send an engineer to give them such advice as we can, provided the engineer's traveling expenses are paid. No charge is made for services rendered.

Our State law requires the county engineer or county surveyor to furnish any farmer plans and specifications for earth reservoirs at county expense, and this office is furnishing the information sent you to the engineers and surveyors for their general guidance in this work.

I am of the opinion that a general impression prevails in the other States that Governor Hodges has planned to build thousands of large reservoirs, which is not the case. The recent drought caused more suffering in Kansas due to the lack of stock water than anything else. Most of our people, I believe, appreciate the fact that an ordinary "sky pond" will be of practically no value when it is needed worst, but there are few sections of the State where ample water could not be had either from wells or springs if a proper reservoir is built to store it in. Our position here is that wherever it is possible to construct ponds and keep them supplied with running water continually it will be a good investment, provided the pond is properly located, well built, fenced to keep the cattle out and the water piped from the pond to a trough below for stock water. In order that the reservoir may be more than just a pond of water, it should be stocked with fish and made just as nearly a permanent improvement on the farm as possible. Many of these reservoirs could be placed so as to supply water for irrigating a garden or a few acres of truck and thus be made very profitable. In fact, there are many such ponds in the State at the present time.

I do not know anything definite about the Governor's plans for a "pond week;" as it has been advertised, but apparently he has not given up the notion. However, I am satisfied that it was not his intention to build reservoirs simply to store the flood waters but to provide wherever possible adequate stock water to tide over during seasons like the past one and to furnish water for irrigation where suitable locations for reservoirs could be had.

W. S. Gearhart,
Manhattan, Kans. State Engineer.

[The "General Directions for Earth Reservoir Construction" to which Mr. Gearhart refers contain detailed information on location, dimensions, materials, foundations, core walls, placing materials, wasteways, waterproofing, and reservoir protection.—Editor.]

Fresh and Decomposed Sludge

Dear Sir: The interesting paper of Messrs. Bach and Frank, in the Engineering Record of Sept. 20, page 331, attempts to set forth the characteristics of fresh and partly decomposed sewage sludge, as obtained at four of the sewage treatment plants of the Emscher Association—Recklinghausen, Schwerin, Holzwickede and Essen-Nord. The populations of these places are respectively about 30,000, 3000, 3500 and 180,000, and the average dry-weather flows are respectively 2,280,000, 53,000, 80,000 and 16,000,000 gal. per day. Numerous analyses of fresh and partly decomposed sludge deposited at these points were made, the number of samples, analyzed being as follows:

NUMBER OF SLUDGE ANALYSES

Plant	Fresh	Decomposed
Recklinghausen	21	5
Schwerin	5	1
Holzwickede	10	1
Essen-Nord	15	71

The age of the partly decomposed sludges ranged from 4 to 6 months at Recklinghausen, 11 to 13 months at Schwerin, 7 to 10 months at Holzwickede, and 3 to 4 months at Essen-Nord, and the analytical results are all expressed as averages, except for the decomposed sludge of the small plants at Schwerin and Holzwickede, where only one sample of such sludge was examined. The tables show the increase or decrease of mineral and organic matters, and also that of the fats, nitrogen, fixed carbon and volatile matter in the partly decomposed sludge as compared with the fresh sludge; but it should be noted that these figures are percentages instead of differences, and that in the increases the percentage is erroneously referred to the decomposed instead of to the fresh sludge, so that all the given percentages of increase are too low. Thus in Table 2, page 331, relating to the Recklinghausen sludge data, the mineral matter of the dried sludge is given as 30.2 per cent, and that of the dried decomposed sludge as 45.9 per cent, with an increase of 34.2 per cent; but the figures show an increase of 45.9 — 30.2 = 15.7 per cent, which is 34.2 per cent of 45.9 and 52.0 per cent of 30.2. The percentages of increase and decrease should obviously refer to the data for the fresh sludge in both cases. By making the corrections indicated, the percentages of increase (+) and decrease (—) of the stated quantities of matter in the dried fresh sludge, which result from comparison with the similar contents of the dried decomposed sludge, will be as follows, the figures all being in per cent:

Locality	Mineral matters	Organic matters	Fats	Nitrogen	Fixed carbon	Volatile matters
Recklinghausen..	+52.0	—22.5	—27.0	—4.2	+2.2	—31.1
Schwerin.......	+18.8	—16.2	—55.8	—6.2	—5.4	—26.1
Holzwickede.....	+58.4	—45.2	—37.1	—41.2	—37.7	—49.1
Essen-Nord.....	+16.3	—16.9	—54.7	—25.0	+4.9	—25.8

It should be noted that only a single analysis of the dried decomposed sludge at Schwerin and Holzwickede was made, and hence that the foregoing figures relating to these two small plants are subject to some change after other analyses of the sludges are made.

In Table 1, page 331, showing the composition of the sewage at the four plants mentioned, a discrepancy occurs between the figures of total suspended matter in the influent and effluent of the Schwerin tank after a detention period of two to three hours, and the quantity of sludge in cubic centimeters that is capable of settling in two hours from samples of said influent and effluent. The first-named figures indicate that 504 — 123 = 381 parts per million by weight, or 75.6 per cent of the total dried suspended matters in the sewage settles in the tank during a period of 2 to 3 hours, while the second set of figures indicates that the effluent contains only a trace of sludge after being allowed to settle for 2 hours. The latter figures imply either a more complete sedimentation than 75.6 per cent of the total suspended matters shown by the former figures or that about 120 parts per million by weight of the suspended matters will not settle in 2 hours.

This second implication involves sewage of rather unusual character. A similar comparison of the figures for the three other plants cannot be made, as the periods of detention in the tanks are all less than 2 hours. It may also be noted that in the case of the Essen-Nord plant a sedimentation of the crude sewage during 1 hour appears to leave 164 parts per million by weight of total suspended matter in the effluent, and that only a trace of this matter in the effluent is capable of settling in 2 hours. The crude sewages of many American cities contain little more than 164 parts per million of suspended matter—Boston, 135; Brockton, Mass., 195; Chicago, 141; Columbus, O., 215; Gardner, Mass., 154; Lawrence, Mass., 149; Marlboro, Mass., 137; Philadelphia, 189; Plainfield, N. J., 173; Waterbury, Conn., 165; and it is known that a large percentage of this matter will settle in 2 hours. Some further explanation of the sedimentation data given in Table 1 is therefore desirable, especially as other modes of computing the weight of dry suspended matter in parts per million from the volume of sludge in cubic centimeters per liter of sewage and the usual proportion of water in the sludge fail to establish an approximate agreement.

Reference is made to the relation of the volume of a sludge to its percentage of moisture and the specific gravity of the dry solids in dense mass. With the following notation: V_o and W_o = initial volume and weight of wet sludge containing the proportion by weight, P_o, of water; V_1 and W_1 = volume and weight of the same partly drained sludge containing the proportional weight, P_1, of water; n = specific gravity of the dry suspended solids in dense mass; then the said relations will be:

$$W_1 = \left(\frac{1 - P_o}{1 - P_1}\right) W_o, \text{ and}$$

$$V_1 = \frac{1 - P_o}{1 - P_1}\left(\frac{1 + P_1 (n - 1)}{1 + P_o (n - 1)}\right) V_o$$

From the latter equation it is seen that when the specific gravity, n, of the dense suspended matter is equal to 1, or is the same as that of water, then the volumes will be directly proportional to the weights. The said relations are based on the simple condition that the quantity or weight of the dry suspended matter in the original volume of wet sludge is not altered by removing a portion of the admixed water.

The subject of the utilization of the sludge of sewage treatment works has always been highly important, and the numerous efforts to find other uses for it than its application to agricultural lands as a fertilizer show plainly that practical farmers generally do not consider its manurial value to be worth the cost of its transportation. There are many hygienic objections to its use on garden lands and pastures, and some skilful farmers allege that it is nearly worthless for grain fields, probably in consequence of its contents of fatty matter. In the past it was very troublesome to get rid of fresh sludge, and in more recent years the partly decomposed and offensive sludge of septic tanks is far from being in active demand.

It is also evident from the publications of the Emscher Association that the more thoroughly decomposed and comparatively odorless drained sludge of the Imhoff tanks is not finding a brisk agricultural market, and that its use for filling low lands in the vicinity of the plants cannot continue indefinitely. Doubtless this is the reason why efforts are now being made in numerous places in Europe to find some way of treating the drained sludge of large sewage plants so as to make the net cost of its removal a minimum, even if an actual profit cannot be attained.

All such efforts are of great interest to those who design and operate sewage-treatment works, and it is to be hoped that Messrs. Bach and Frank will soon discover a process of utilizing sludge that will be as far in advance of other methods as the Imhoff tank is ahead of other sewage tanks in respect to the production of decomposed sludge that is practically odorless, relatively small in quantity and easily drained. This problem seems to be very difficult in view of the variations in the quality of sewage sludge due to industrial wastes and seasonal temperatures whereby the processes of fermentation are modified.

E. KUICHLING,
New York. Consulting Engineer.

Dear Sir: The article on "Fresh and Decomposed Sewage Sludge," by Messrs. Bach and Frank of the technical staff of the Emscher District of Germany, covers a question which has often been raised and not answered with facts until the mentioned experiments were made. These are, therefore, a welcome contribution to knowledge regarding sewage sludges.

We still hear from national economists regarding the inexcusable wastefulness of letting sewage with its great (?) manurial value go into rivers or into the sea, and of all sorts of means, more or less complicated and expensive, to extract the insignificant portion of matter which has some manurial value from the rest of the dirty water which has no value at all, except possibly as water for irrigation or power. This clamor has now become less frequent, but another one is taking its place—the utilization of fresh sewage sludge resulting from the settling and compacted solid matter, which in bulk amounts to less than one-two thousandth part of the sewage. No doubt the elimination of the enormous amount of water gives the resulting sludge, as such, a greater value. Its comparatively small bulk can be more economically handled and applied, and it contains most of the plant food which is contained in sewage.

There comes now the question, which is discussed in the above-mentioned article, relating to a comparison of freshly settled sludge, having 90 to 95 per cent of water, with the decomposed and dried sludge, as obtained from the Imhoff tanks, having only 48 to 66 per cent of water. The conclusion reached in the article is that whatever profit there may be from the manurial contents it will probably be greater in the case of the decomposed Imhoff sludge, with the smaller water content and having other advantages, than from the fresh sludge with the larger water content. This conclusion is in line with the well-known increase of value in the high-grade manures, such as guano, where a minimum of moisture gives a maximum of value.

Messrs. Bach and Frank call attention to a "popular fallacy" and say: "Many engineers in thinking of reduction in moisture percentage from, say, 90 to 60 per cent consider that the volume of the 60 per cent sludge is 25 per cent of the volume of the 90 per cent sludge." Instead of the volume these figures should relate to the weight. "The volume has been reduced to less than 25 per cent of its former value, because the specific gravity of the dry substance is greater than the specific gravity of water." Perhaps some engineers may have made this mathematical error. It is more apt to be made by chemists, whose profession does not require an equally frequent and extended use of mathematics. Three years ago I read a paper before the American Institute of Chemical Engineers and said in my discussion: "As a matter of fact, if you have a substance containing 95 per cent of water and another containing 90 per cent of water you have diminished the weight one-half." The chemical editor, presumably believing me in error, kindly changed the figure 90 per cent to 45 per cent, making the stated fact absurd.

One hundred pounds of sludge originally containing 95 per cent of water and 5 per cent of solid matter are reduced after various degrees of drying to:

100	lb. of sludge, with	95	per cent of water
50	lb. of sludge, with	90	per cent of water
25	lb. of sludge, with	80	per cent of water
16⅔	lb. of sludge, with	70	per cent of water
12½	lb. of sludge, with	60	per cent of water
10	lb. of sludge, with	50	per cent of water
8⅓	lb. of sludge, with	40	per cent of water
5	lb. of sludge, with	0	per cent of water

In view of some of these "fallacies" the above table gathered from an old text book should help in removing one of them.

RUDOLPH HERING,
New York. Consulting Engineer.

Dear Sir: The article on "Fresh Sludge and Decomposed Sludge," by Hermann Bach and Leslie C. Frank, is interesting from a technical standpoint. Anyone that has had occasion to deal with the handling of sludge realizes that the main difficulty encountered is the reducing of the percentage of moisture to a point where it can be satisfactorily handled for transportation. Various methods are being tried to accomplish this. Up to the present it is a question whether this reduced moisture has been secured at a satisfactory cost.

I do not know that it is necessary to go through the exhaustive experiments that this article mentions in order to demonstrate the fact that it is cheaper to handle sludge with a less amount of moisture than with the amount of moisture reduced. This is a self-evident fact that is well-known to engineers that have had any experience in this line. The point, as stated above, is to be able to secure the removal of this moisture at the least cost. We are experimenting along these lines at our works in Baltimore and hope to be able to give some interesting results in the near future.

CALVIN W. HENDRICK,
Chief Engineer, Sewerage Commission.
Baltimore.

Highest Railways in the World

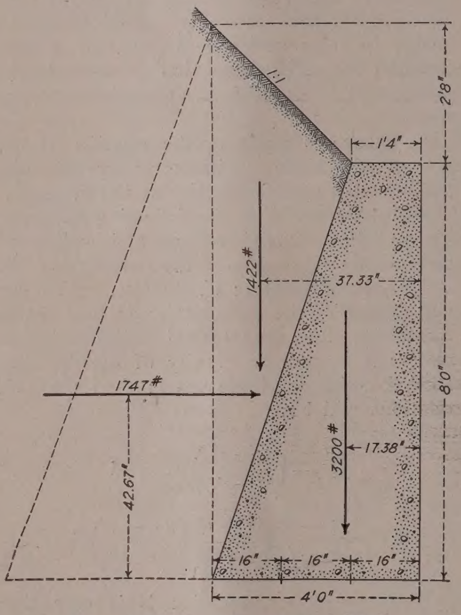
Dear Sir: I see that in your issue of Sept. 20 in the article entitled "Highest Railways in the World" you give 16,006 ft. as the highest point on the Rio Mulato-Potosi line. This is wrong. The highest point is 15,816 ft., or about 4820 meters. There are two other lines in Bolivia going over 14,000 ft., the Oruro-Cochabamba and the Uyuni-Tupiza. The writer had charge of the surveys and construction of these lines.

I have been told that there is a branch to the Peruvian Central Railway running up to a mine at an elevation of nearly 17,000 ft. The Peruvian Southern Railway crosses the Andes at a point called Crucero Alto at a height of 14,666 ft.

WILLIAM L. GIBSON.
San Antonio, Tex.

How Not to Build a Retaining Wall

Dear Sir: In your issue of Sept. 20, page 324, there is an article by Prof. L. E. Moore entitled "How Not to Build a Retaining Wall." In this article Professor Moore criticises severely the design of the structure and tries to prove that the wall in instable. A few mistakes, however, on Professor Moore's part account for his wrong statements. First, the weight of the wall does not act through a point 13.67 in. back from the outside. For a triangular shape of wall the gravity line goes through the middle-third point, and as the shape of the wall in question consists of a triangle plus a rectangle it is obvious that this gravity line must fall inside of the middle third. In this case it falls 1.38 in. inside, giving the weight a lever arm of 17.38 instead of 13.67 in. If the statement that the earth pressure *P* acts half way up on the back of the wall is true, the accompanying batter of the surcharge is 1½ on 1, corresponding to an angle of slope of 56 deg. 20 min. It is not likely that this slope is as steep as that; a slope 1 on 1 would probably conform more nearly to the actual conditions. Such a condition is shown in the accompanying drawing.



Arrangement of Earth and Wall

The overturning moment for earth weighing 100 lb. per cubic foot and having an angle of repose of 32 deg. is 6212 ft.-lb., using the common formulæ for earth pressures. On the back of the wall there rests a prism of earth of triangular cross-section, the weight of which is 1422 lb., having a lever arm of 37 1-3 in. The total resisting moments are, therefore, 4635+4424=9059 ft.-lb. From this calculation it is evident that the factor of safety is 9059/6212=1.46.

As has been stated on several occasions by experts, and actually shown by experiments, the earth-pressure theories give pressures from 2 to 2.5 times larger than those actually existing. The discrepancy between theory and practice is accounted for by neglecting the cohesion of the earth in the calculations. The wall in question, therefore, has a factor of safety of at least 3, which ought to be considered a very safe margin.

If the wall had been turned around to secure greater stability, as Professor Moore suggests, the resisting moment would have been 8168 ft.-lb., or about 10 per cent. less than in its original position.

New York City. K. A. ALBERT.

Dear Sir: In the short article which I sent you an "How Not to Build a Retaining Wall," which appeared in your issue of Sept. 20, page 324, the location of the center of gravity of the wall should have been 17.7 in. in from the vertical face instead of 13.67 in. This brings the weight just inside the middle-third point of the base, but does not alter the essential argument which I put forth in the article.

Boston. LEWIS E. MOORE.

Large Tank at San Francisquito Power Station No. 1

Dear Sir: I have been much interested in your description of the San Francisquito standpipe appearing in the Engineering Record of Sept. 13, page 299. I believe you must be mistaken in the function which this chamber has been designed to perform, for otherwise it would be an example of extravagance. According to your description, its chief virtue, attributable by inference to the conical shape, seems to be to produce non-oscillating regulation of a conduit 7½ miles long and 10 ft. 2 in. in diameter for a velocity change of 40 per cent, corresponding to a load change of 34 per cent from 66 per cent load to full load. The quantities of water involved are 600 sec.-ft. at an initial velocity of 7.4 ft., with a friction loss of about 46 ft., and 1,000 sec.-ft. corresponding to a velocity of 12.34 ft., with a friction loss of 127 ft. The gross head is 941 ft. These figures were taken from the data submitted, and computed upon the rough assumption that the friction loss varies as the square of the velocity. The data would lead to no such huge design as indicated, and I assume either that something is contemplated beyond what appears in your statement or that I have misinterpreted the data. A cylindrical differential regulator no larger than the bottom 30 ft. diameter of this cone would be far more than sufficient to give a strictly non-oscillatory wave, and if carried 35 ft. above forebay level no water would spill with a complete shutdown at any velocity. A simple cylindrical standpipe 39 ft. in diameter with no differential action whatever would afford strictly non-oscillatory conditions upon the above assumptions. The formula for non-oscillatory or "dead-beat" conditions for the differential regulator is as follows:

$$F = \frac{LA}{gC^2(V_2^2 - V_1^2)} \log_e \frac{2V_2}{V_2 + V_1} + A$$

Where CV_2 = the friction loss; $V_2 - V_1$ = the total velocity change in conduit; F = tank area; L = length of conduit; A = area of conduit.

The formula for "dead-beat" conditions for a simple standpipe derived by Herr Thoma is as follows:

$$F = \frac{LA}{2gC(H - CV_1^2)}(1 + Z + \sqrt{{}^{2}(Z+2)}$$

$$\text{Where } Z = \left\{\frac{H - CV_1^2}{V_2(H - CV_2^2)}\right\}^2 \frac{H - 3CV_1^2}{C}$$

and H is the gross head.

Substituting the values: $L = 39600$; $A = 81$; $C = 0.835$; $V_1 = 7.4$; $V_2 = 12.34$; $H = 941$, we find the value of $F = 409$ sq. ft. for the differential regulator and $F = 1150$ sq. ft. for the simple standpipe.

Although the non-oscillatory, or dead-beat," wave may be ideal, yet it is often far too costly to obtain, and a moderate amount of surging permitted rapidly reduces the dimensions of the regulator to a commercial basis and does not appreciably injure the regulation.

Niagara Falls, N. Y. R. D. JOHNSON.